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The Distribution of the Genus Phytophthora

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The Distribution of the Genus Phytophthora

C. M. Tucker

Abstract.—A compilation of the published information on the occurrence of species of *Phytophthora* on cultivated and wild hosts, with notes on their geographic distribution and on the characteristic symptoms of infection. Natural infections are reported on 216 host species representing 149 genera and 67 families. Data from artificial inoculations, included in the bulletin, indicate susceptibility to infection in 82 species representing 45 genera and 6 families, in addition to those above.

The species of *Phytophthora* are generally recorded under the names reported by the authors, except when the non-validity of such names has been clearly established.

A page index of hosts and a bibliography of more than 500 titles are included.

The wide geographic distribution of the genus Phytophthora has been a frequent subject of comment. Equally interesting and important is the occurrence of diseases caused by various species on a large number of families of Spermatophyta. The genus attacks families widely separated in the usual phylogenetic classifications. Some species are omnivorous, invading representatives of several families. *P. cactorum* and *P. parasitica* are good examples of this type. *P. thalictri* and *P. phaseoli*, on the contrary, are very restricted in their parasitism and are confined to a single host genus or even species.

The following host list may prove convenient to other workers. It is sometimes quite evident that determinations are erroneous. The most conspicuous errors are called to the reader's attention. Doubtful determinations are included, generally without comment. Identifications under specific names now obsolete are referred to the modern nomenclature when it is reasonably certain that no confusion will result. Occasionally unidentified species are referred to particular species when the context clearly justifies such action, and such identifications are in accordance with the writer's studies (482)* on the taxonomy of the genus.

It has sometimes been difficult to determine whether authors have listed hosts on which they have found certain species occurring in nature or hosts on which they have obtained infections as the result of inoculation. An effort has been made to distinguish the latter from the former. It may be reasoned that any plant susceptible to infection through inoculation may, under certain circumstances, become infected naturally.

*Reference by number to "Literature Cited," Pages 59-75.

However, a consideration of *P. parasitica*, one of the most cosmopolitan species, shows that it is likely to attack a great many young wound-inoculated seedlings on which natural infections are unknown. Infections resulting from inoculations are, therefore, designated as such.

No complete descriptions of the symptoms produced on the hosts by the fungi are given. Brief notes on the nature of the injury, portions of the host attacked, etc., are included in some instances. The citations to the authors reporting the species are intended to be to the earliest reports, although some of the earlier workers may have been overlooked, due to the obscurity of the articles in question, inability to obtain them, or to carelessness in abstracting.

The host nomenclature follows Britton and Wilson (64) for many common tropical plants; Bailey (29) is generally used as the source of names for cultivated plants of the temperate zone and for some of the tropics; Gray (191) for wild plants of the American temperate regions and Engler and Prantl (148) for some of the European and Asiatic hosts. In the Rutaceae the nomenclature used by Hume (227) is adopted. A few species were found only in the Index Kewensis.

Aceraceae

ACER SP. Maple.

P. cactorum. Reported by Hartig (204) in 1882 in Germany and by Collinge (107) in 1912 in England as the cause of a seedling disease.

ACER PALMATUM Thunb. Japan Maple.

P. cactorum. Stevenson (453) in 1926 listed this species as a host in Europe.

ACER PSEUDOPLATANUS L. Sycamore Maple.

P. syringae. Klebahn (241) in 1909 obtained slight infection of inoculated twigs.

Amaranthaceae

AMARANTHUS SP. Amaranth.

P. nicotianae. Breda de Haan (59) in 1896 reported attacks on this host in Java by his tobacco fungus.

Amaryllidaceae

AGAVE AMERICANA L. Century Plant. American Aloe.

P. agaves. Gándara (176) in 1909 reported this species, of which no description has been seen, causing spots on the leaves in Hidalgo, Mexico.

Anacardiaceae

MANGIFERA INDICA L. Mango.

Phytophthora sp. Narasimhan (306) in 1927 observed an unidentified species on leaves in India.

P. palmivora. Reinking (376) in 1921 reported a seedling blight in the Philippine Islands caused by a species resembling *P. palmivora* and

in 1923 (377) obtained slight infections by inoculations with Philippine cacao and coconut strains of the species.

SPONDIAS LUTEA L. Hog Plum. Jobo.

P. palmivora. Reinking (373) in 1919 killed seedlings by inoculations with a Philippine cacao strain.

Annonaceae

ANNONA GLABRA L. Pond-apple. Alligator-apple. Monkey-apple.

P. palmivora. Reinking (377) in 1923 obtained slight infections of seedlings inoculated with Philippine coconut and cacao strains.

ANNONA MURICATA L. Soursop.

P. palmivora. Reinking (373) in 1919 killed seedlings by inoculation with a Philippine cacao strain, and in 1923 (377) with a coconut strain.

CANANGIUM ODORATUM King. Ylangylang.

Phytophthora sp. Ciferri (95) in 1927 found a species associated with dying seedlings in Santo Domingo.

Apocynaceae

CATHARANTHUS ROSEUS (L.) Don. (*Lochnera rosea* (L.) Rehb.) (*Vinca rosea* L.) Periwinkle.

P. parasitica. Dastur (123) in 1916 described a Phytophthora disease in India characterized by attacks on the leaves, growing points, tender stems, fruits and flowers. Invaded regions turn brown and finally black. He considered the causal agent a biologic variety of *P. parasitica.*

Schwarz (402) in 1926 described a disease in Java caused by a species considered probably *P. palmivora.* The disease is very similar to that described by Dastur (123) in India. The writer's (482) examination of the fungus indicates that it should be considered *P. parasitica.* Blanchard (54) in 1930 reported the species in Argentina.

ODONTADENIA GRANDIFLORA Schum. (*O. speciosa* Benth.)

P. palmivora. Gadd (172) in 1924 found the species attacking leaves, flowers and buds in Ceylon. A rapid dying back of invaded shoots occurred.

Aquifoliaceae

ILEX PARAGUARIENSIS St. Hil. Paraguay Tea.

Phytophthora sp. Blanchard (53) in 1928 reported an unidentified species causing a damping off of young plants in Argentina.

Araceae

CALADIUM COLOCASIA (L.) Wight. (*Colocasia antiquorum* Schott.) Dasheen. Taro.

Phytophthora sp. Venkata Rao (494) in 1930 reported the isolation, in India, of a species similar to *P. arecae.*

P. colocasiae. This species is widespread and frequently of considerable importance. The disease is usually confined to the leaves as

more or less circular brown spots which become papery and brittle on drying. Under very favorable conditions infection may extend to the petioles and corms and result in a wet rot. A dry rot of corms in storage has once been attributed to the species. Its distribution has been reported as follows: Java, by Raciborski (364) in 1900; India, by Butler and Kulkarni (85) in 1913; Formosa, by Sawada (395) in 1911; the Philippine Islands, by Mendiola and Espino (289) in 1916; Ceylon, by Petch (335) in 1918; Guam, by Weston (509) in 1918; Southern China, by Reinking (374) in 1919; Hawaii, by Carpenter (90) in 1919.

P. parasitica. Dastur (123) in 1916 obtained infection of wounded corms inoculated with a Catharanthus strain.

ZANTEDESCHIA AETHIOPICA Spreng. (*Richardia aethiopica* Hort.) Calla Lily.

P. richardiae. Buisman (73) in 1927 described a root disease which occurs in Holland. At about flowering time a yellowing of the outer leaves occurs. Infected plants are not killed, but remain unhealthy and produce only a few small flowers. Invaded roots are flaccid and glassy and frequently show reddish discolored regions. Salmon and Ware (391) in 1927 studied a very similar disease in England and found the causal fungus similar to or identical with *P. richardiae.*

Chester (93) in 1930 stated that the disease had appeared in America in a greenhouse in Massachusetts and Weiss (506) reported it in the same year from New York, New Jersey and probably California. In 1932 Tilford* reported it prevalent in Ohio.

Araliaceae

PANAX QUINQUEFOLIUM L. Ginseng.

P. cactorum. Van Hook (216) in 1906 reported a common and serious disease in Ohio and New York caused by *P. cactorum.* The symptoms are a drooping of the leaflets and the appearance on them of water-soaked dark green spots which later become white in the center. Invasion of the stems results in a watery discoloration followed by hollowing and collapse. The roots may undergo a semi-soft rot. Whetzel (510) in 1910 obtained the fungus in culture. Hori (220) reported the disease as common in Japan in 1907; Anderson, Häskell and others (8) in 1926 reported its occurrence in the United States in Connecticut, New York, Pennsylvania, Ohio, Indiana, Michigan, Iowa and Washington.

Betulaceae

ALNUS GLUTINOSA Gaertn. Black Alder.

P. syringae. Klebahn (241) in 1909 obtained slight infections on inoculated twigs.

CORYLUS AVELLANA L. Hazelnut. Filbert.

P. cactorum. Meurs (290) from a study of unpublished data

*Tilford, Paul E. Calla lily root rot and its control. 1932. O. Agr. Exp. Sta. Bimonthly Bull. 157, 138-140.

identified a fungus isolated from a rotting fruit in Holland as *P. cactorum*.

P. syringae. Klebahn (241) in 1909 reported slight infections of inoculated twigs.

Bombaceae

CEIBA CASEARIA Medic. (*C. pentandra* Gaertn.) Silk-Cotton tree.

P. palmivora. Hartley (206) in 1924 successfully inoculated bark and ripe and unripe fruits with a Java cacao strain. Natural infections occur rarely in Java.

Bromeliaceae

ANANAS ANANAS (L.) Cockerell. (*A. sativus* Schult.) Pineapple.

Phytophthora spp. Waldron (499) in 1927 described a rot of green, immature fruit in Hawaii. It becomes evident externally as a brown patch involving one or more fruitlets. Longitudinal sections reveal an infected area, whiter than normal tissue, and edged with brown. The fleshy region is decomposed but the central core is not invaded.

Sideris (415) in 1929 observed a stem and root rot of young plants in Hawaii. Infection occurs through the roots. The fungus was considered probably a chlamydospore-producing Phytophthora. In 1932 (417) he reported a species, possibly of the *P. cambivora* group, weakly pathogenic to inoculated roots.

P. cinnamomi. According to information communicated by F. P. Mehrlich this species was isolated by C. P. Sideris in Hawaii from diseased leaves and stems; the fungus was to have served as the type for a new genus, Pseudopythium, mentioned by Sideris (417) in 1932. A subculture sent to the writer in 1931 is typical of *P. cinnamomi*, confirming Mehrlich's identification.[1]

Simmonds obtained the species in Australia, according to information transmitted by R. P. White.

P. meadii. Sideris (415) in 1929 reported this species as the cause of a fruit and stem rot in Hawaii. Sideris and Paxton (418) in 1929 reported a species as a parasite of roots, identifying it in 1931 (420) as *P. meadii.*

P. palmivora. Mehrlich, in 1933, obtained typical heart rot of inoculated fruits (from unpublished data).

P. parasitica. Ashby (18) in 1920 reported this species on leaf bases and stems in Jamaica. A subculture of his fungus in the writer's collection confirms his identification (482). Bruner (68) in 1932 isolated the species from diseased plants in Cuba. The first symptom of the disease is frequently a tilting of the plants to one side caused by the invasion and weakening of the stem near the base. Infection of the leaves near the bases causes a slightly darkened, water-soaked decay permitting

[1]MEHRLICH, F. P. 1932. *Pseudopythium phytophthoron* a synonym of *Phytophthora cinnamomi.* Mycol. 24: 453-454.

easy detachment of infected ones. Sideris (415) in 1929 obtained the species from a stem rot in the Hawaiian Islands. He identified it as *P. melongenae*, which should be considered a synonym of *P. parasitica*. Sideris and Paxton (418) in 1929 reported the species, identified in 1931 (420), as a root parasite. Blanchard (54) reported the species in Argentina in 1930.

Cactaceae

CACTUS SPP. Cactus.

P. parasitica. Matz (278) in 1920 regarded it as the chief cause of failure of Cactus introductions in Puerto Rico.

CEREUS GIGANTEUS Eng.

P. cactorum. Lebert and Cohn (255) in 1870 described *Peronospora cactorum* from this and other species in Germany. Infection produced a disintegration of the tissues accompanied by a decomposition or dissolution of the middle lamellae.

CEREUS MARTIANUS Zucc.

P. cactorum. Himmelbaur (214) in 1911 obtained infection by inoculation.

P. syringae. Himmelbaur (214) in 1911 reported successful inoculations.

CEREUS PERUVIANUS Haw. Hedge Cactus.

P. cactorum. De Bary (131) in 1881 infected this host by inoculation.

CEREUS PITAJAYA DC. (*C. formosus* Salm.-Dyck.)

P. arecae. Coleman (105) in 1910 obtained infection of cuttings by inoculation.

CEREUS SPECIOSUS (Cav.) K. Sch. (*C. speciosissimus* (Deaf.) DC.)

P. cactorum. De Bary (131) in 1881 made successful inoculations.

CEREUS TETRACANTHUS Labour.

P. cactorum. Himmelbaur (214) in 1911 infected plants by inoculation.

P. syringae. Himmelbaur (214) in 1911 secured infection by inoculation.

ECHINOPSIS EYRIESII Zucc. Sea-urchin Cactus.

P. cactorum. Himmelbaur (214) in 1911 reported successful inoculations.

P. syringae. Himmelbaur (214) in 1911 reported infection of inoculated plants.

EPIPHYLLUM TRUNCATUM Haw.

P. allii. Sawada (Tanaka's translation) (460) in 1915 secured infection by inoculation.

MAMMILLARIA SP.

P. cactorum. Lafferty and Pethybridge (251) in 1922 reported successful inoculations.

MELOCACTUS NIGROTOMENTOSUS (*Cactus sp.*) (?)

P. cactorum. Lebert and Cohn (255) in 1870 described *Peronospora cactorum* from this and other naturally infected Cactaceae in Germany.

OPUNTIA FICUS-INDICA Mill. Indian Fig.

P. hydrophila. Curzi (118) in 1927 found this species parasitic on inoculated cladodes.

PHYLLOCACTUS SP.

P. cactorum. Rosenbaum (383) in 1915 reported studies on a strain isolated from this host by Peters in Germany.

Capparidaceae

CLEOME VIOLACEA L.

P. cactorum. De Bary (131) in 1878 observed a foot and stem rot and occasional leaf infections in Germany.

Caryophyllaceae

DIANTHUS CARYOPHYLLUS L. Carnation.

Phytophthora sp. Haigh (196) in 1931 reported an unidentified species in Ceylon.

P. cactorum. Müller-Thurgau and Osterwalder (301) in 1924 reported attacks on stems at the soil level in Switzerland by *P. omnivora.* In other publications Osterwalder (319) has referred to *P. cactorum* as *P. omnivora.*

Chenopodiaceae

BETA VULGARIS VAR. CRASSA Alef. Sugar Beet.

P. cactorum. Stevens and Plunkett (449) in 1925 reported a damping off of seedlings as the result of inoculation with a tulip strain.

P. Drechsleri. Tompkins sent the writer isolations from sugar beets affected by a wet rot in Utah and California. The isolations are identical with *P. Drechsleri*, previously known only from an isolation from a rotting potato tuber from Idaho (482).

SPINACIA OLERACEA L. Spinach.

Phytophthora sp. Anderson, Haskell and others (8) in 1926 recorded the occurrence of a crown rot caused by an undetermined species in New Jersey and Indiana.

Sideris (417) in 1932 described a fungus from diseased roots in Hawaii as *Pythium teratosporon* n. sp. In an appended note he states, "*Pythium teratosporon* has been found through later studies of the writer to belong to Phytophthora and possibly in the group of organisms related to *Phytophthora cambivora*, and should be considered definitely a species of Phytophthora."

Commelinaceae

COMMELINA BENGHALENSIS L.

P. nicotianae. Palm and Jochems (324) in 1924 observed that

young plants in tobacco seed-beds in Java were very susceptible to natural infection.

COMMELINA NUDIFLORA L.

P. nicotianae. Palm (323) in 1923 observed infections in Sumatra. Atanasoff and Kovacevski (27) in 1929 reported the species in Bulgaria.

POLLIA SP.

P. parasitica. Ashby (23) in 1928 mentioned the isolation of the species in Java by Jochems. Examination of the writer's culture of a Javan strain confirms the identification (482).

Compositae

ASTER SP. Aster.

P. cactorum. Müller-Thurgau, Osterwalder and Jegen (302) in 1922 attributed an invasion of plants at the soil level in Switzerland to *P. omnivora.* Osterwalder, in other articles (317) (319), has referred to *P. cactorum* as *P. omnivora.* Smolak (437) in 1925 recorded attacks by *P. omnivora* in Czecho-Slovakia.

P. cryptogea. A disease characterized by the invasion and blackening of the stems near the base is known in England as "black leg," "black neck", foot rot and wilt disease. In 1915 Robinson (379) isolated a fungus similar to *P. cryptogea* and Williams (515) in 1927 made the identification. Pethybridge and Lafferty (350) in 1919 isolated it in Ireland.

BIDENS PILOSA L.

P. parasitica. Mehrlich, in 1933, obtained infection of unwounded seedlings (from unpublished data).

CALLISTEPHUS CHINENSIS Nee. China Aster.

Phytophthora spp. Gloyer (187) in 1924 recorded a species as a parasite on the host in New York.

Drechsler, according to Martin (272), reported "black leg," caused by a Phytophthora, in the District of Columbia in 1926.

P. cryptogea. Brittlebank and Fish (63) in 1927 found the species causing a disease in Australia. Browning of the stem bases and yellowing of the foliage, especially at flowering time, are the most noticeable symptoms.

CINERARIA SP.

P. cryptogea. Bewley (51) in 1921 reported the species as the cause of a foot rot in England. Brittlebank and Fish (63) in 1927 reported a similar disease in Australia as a result of *P. cryptogea* infection.

LACTUCA SATIVA L. Lettuce.

P. parasitica. Ocfemia (311) in 1925 reported the infection of inoculated leaves by an eggplant strain which he considered *P. melongenae* (*P. parasitica*).

Convolvulaceae

IPOMOEA BATATAS (L.) Lam. Sweet Potato.

Phytophthora sp. Snowden (439) in 1927 reported the presence of an undetermined species, among other fungi, in rotting sweet potato roots in Uganda.

P. nicotianae. Tisdale and Kelley (471) in 1926 obtained a spongy, slightly watery rot of wound-inoculated fleshy roots.

Crassulaceae

BRYOPHYLLUM PINNATUM (Lam.) Kurz. (*B. calycinum* Salisb.)

Phytophthora spp. Narasimhan (305) in 1924 recorded an undetermined species on this host in India, and in 1927 (306) noted the occurrence of oospores in infected leaves. Venkata Rao (492) in 1925 reported sporangia similar to those of *P. arecae* on leaves.

P. parasitica. The writer (480) in 1928 reported a black rot of leaves and stems in Puerto Rico. Infection on the leaves caused dark green, watersoaked areas which later become soft and black. A strain isolated in 1927 in Bermuda by Ogilvie and received from Chupp is very similar to the Puerto Rican isolation and the writer has referred both to *P. parasitica* (482). Leonian and Geer (260) in 1929 identified a Bermuda strain as *P. omnivora*, which, according to their scheme of nomenclature, is a group to which *P. parasitica* belongs.

COTYLEDON SP. Cotyledon.

P. parasitica. Hopkins[1] in 1932 reported a purple rot in Southern Rhodesia caused by this species and *Rhizoctonia sp.*

SEDUM PURPUREUM Tausch. Garden Orpine. Live-for-ever.

Phytophthora sp. Chupp, according to Martin (270) in 1922 reported a stem rot caused by an undetermined species in New York. The distribution of infected plants was found a valuable measure in eradicating this troublesome weed. The disease spread until the host was eradicated (presumably in localized areas).

SEMPERVIVUM ALBIDUM Schnittsp. and Lehm.

P. cactorum. Schenk (398) in 1875 described *Peronospora Sempervivi* from this and other species in Germany. It causes a rot of stems, leaves and flowers, usually originating on the young, partially developed inflorescences.

SEMPERVIVUM ARBOREUM-RUBRUM (*S. arboreum* L.) (?)

P. cactorum. Lafferty and Pethybridge (251) in 1922 produced a rot by inoculations with strains from several hosts.

SEMPERVIVUM BERTHELOTIANUM (?)

P. cactorum. Lafferty and Pethybridge (251) in 1922 found

[1]HOPKINS, J. C. F. 1932. A list of plant diseases occurring in Southern Rhodesia. Supplement 2. Min. Agr. and Lands. Southern Rhodesia, Bull. 856, 8 pp.

strains from various hosts capable of causing a rot of inoculated plants.

SEMPERVIVUM GLAUCUM Tenore.

P. cactorum. Schenk (398) in 1875 described *Peronospora Sempervivi* from this and other species in Germany. (See *S. albidum*).

SEMPERVIVUM STENOPETALUM Schnittsp. and Lehm.

P. cactorum. One of Schenk's (398) original hosts. (See *S. albidum*).

SEMPERVIVUM TECTORUM L. Hen-and-chickens.

P. cactorum. One of Schenk's (398) original hosts. Germany. (See *S. albidum*).

Cruciferae

BRASSICA JUNCEA L. Chinese Mustard.

P. parasitica (?) Clara (98) in 1928 reported a slight, wet rot caused by inoculations with a species probably referable to *P. parasitica.*

BRASSICA OLERACEA L. Cabbage.

P. cactorum. Young (522) in 1926 obtained infections of inoculated leaves.

BRASSICA RAPA L. Turnip.

P. cryptogea. Pethybridge and Lafferty (350) in 1919 reported active infection of wound-inoculated roots.

P. erythroseptica. Pethybridge (344) in 1913 secured infection of wound-inoculated roots.

P. parasitica. Godfrey (188) in 1923 reported a hard, blackened type of infection following root inoculation with a rhubarb strain.

CHEIRANTHUS CHEIRI L. Wall Flower.

P. cryptogea. Pethybridge and Lafferty (350) in 1919 observed a foot rot in Ireland and considered *P. cryptogea* the probable cause. Brittlebank and Fish (63) in 1927 found a browning near the bases of the stems and a yellowing of the leaves, in Australia, caused by the same species.

LEPIDIUM SATIVUM L. Garden Cress.

P. cactorum. De Bary (131) in 1881 and Klebahn (241) in 1909 obtained infections by inoculations.

RAPHANUS SATIVUS L. Radish.

P. parasitica (?) Clara (98) in 1928 reported a slight, wet rot resulting from inoculations with a species probably referable to *P. parasitica.*

Cucurbitaceae

BRYONIA DIOICA Jacq. Bryony.

P. hydrophila. Curzi (118) in 1927 found the species pathogenic to inoculated fruits.

CITRULLUS CITRULLUS (L.) Karst. Watermelon.

P. citrophthora. Reported in California in 1929 (11).

P. parasitica. Sherbakoff (410) in 1917 produced a fruit rot by inoculation.

CUCUMIS MELO VAR. INODORUS Naud. Honey Dew Melon.

Phytophthora sp. Drechsler (139) in 1929 reported the isolation of a species from melons from Colorado or California. Invaded regions were depressed and watersoaked.

P. cactorum. Drechsler (139) in 1929 produced a fruit rot by inoculation.

P. citrophthora. Drechsler (139) in 1929 produced a fruit rot by inoculation.

P. parasitica. Drechsler (139) in 1929 reported a rotting of inoculated fruits.

CUCUMIS SATIVUS L. Cucumber.

P. parasitica (?) Williams (514) in 1926 observed a root rot and damping off of young seedlings in England caused by a Phytophthora which he considered different from *P. cryptogea* and *P. parasitica.* His description and especially his statement that the optimum temperature of the fungus is approximately 35 degrees C. (516) indicate that it was very probably a strain of *P. parasitica.*

CUCURBITA SP. Squash.

P. citrophthora. Reported in California in 1929 (11).

CUCURBITA PEPO L. Pumpkin.

P. citrophthora. Reported in California in 1929 (11).

P. hydrophila. Curzi (118) in 1927 obtained infections by inoculating seedlings and fruits.

Cyperaceae

CYPERUS ROTUNDATUS (*C. rotundus* L. (?)).

P. cyperi-rotundati. Sawada (397) in 1927 published a Japanese description of this species which occurs in Formosa.

LEPIRONIA SP.

P. lepironiae. Sawada (396) in 1919 described the species in Japanese. Formosa.

Dioscoreaceae

DIOSCOREA BATATAS Decne. Yam.

Phytophthora sp. (?) Hansford (198) in 1923 reported a soft rot of yams in Jamaica with which an undetermined Pythium or Phytophthora was associated.

Ebenaceae

DIOSPYROS KAKI L. Persimmon.

P. hydrophila. Curzi (118) in 1927 obtained infection of inoculated fruits.

Ericaceae

ERICA SP. Heath.

P. cinnamomi. Isolated in New York by Gill, according to a communication from R. P. White.

RHODODENDRON SPP. Rhododendron. Azalea.

P. cactorum. White (513) in 1930 reported the species causing a dieback of native species and hybrids in New Jersey.

RHODODENDRON CALIFORNICUM Hook.

P. cinnamomi. White (513) in 1930 reported the pathogenicity of the species.

RHODODENDRON CAROLINEANUM Rehd.

P. cinnamomi. White (513) in 1930 reported this species pathogenic.

RHODODENDRON PONTICUM L.

P. cinnamomi. White (513) in 1930 reported the species causing a rot of the fibrous roots. It advances up the stem in the phloem and cambium regions. Hybrid seedlings were also attacked. New Jersey.

Euphorbiaceae

ALEURITES FORDII Hemsl. Tung-oil Tree. China Wood-oil Tree.

P. palmivora. Reported as the cause of a leaf-spot in India by Venkatarayan (495) in 1932.

EUPHORBIA RESINIFERA Berg.

P. citricola. Sawada (397) in 1927 reported successful stem inoculations.

P. tabaci. Sawada (397) in 1927 reported successful stem inoculations.

HEVEA BRASILIENSIS (H. B. K.) Muell. Arg. Para Rubber.

An extensive literature has developed in connection with the Phytophthora diseases of Hevea, which are probably coextensive with the host. The symptoms of infection are numerous since species pathogenic to Hevea may attack almost any portion of the tree; the regions attacked and the severity of the resulting disease vary with environmental conditions. *P. meadii*, *P. palmivora*, *P. heveae*, probably *P. parasitica* and a Pythium have been reported as the causal agents of various types of infection. The species most frequently referred to are *P. meadii* and *P. palmivora.* Numerous writers have attributed an infection of the tapping cuts, and the development of "black stripe" disease to *P. meadii*, and considered *P. palmivora* responsible for virgin bark infections which result in patch or claret-colored canker. More recent evidence indicates that each species may cause both types. Fruit rot and abnormal or secondary leaf fall have been attributed to both species, and there are no apparent means of separating the species by the symptoms. The two species are otherwise difficult to distinguish and probably should not be separated. The descriptions of the diseases are combined.

Patch or claret-colored canker is evident externally as an inconspicuous darkening of the bark; in advanced stages there may be an exudation of rusty, brown liquid. Scraping away the outer bark reveals a thin black layer under which the cortex is a dirty red, changing to claret color. Infection extends from the cortex into the cambium. The extension of the cankered area is mostly longitudinal but it may finally girdle and kill the tree. Cankers usually appear on the basal four feet of the trunk. Infections at the collar may spread downward onto the lateral and tap roots. The disease causes a cessation of latex flow and this frequently first directs attention to infected trees.

The rot of the bark on tapping cuts known as black stripe, black thread, stripe canker, bark rot, etc., is caused by invasion through tapping wounds which produces at first, round black spots, usually on the lowest cuts. After a few days long, narrow, parallel black stripes extending deeply into the wood appear on the tapped area. A splitting of the bast along the stripes may occur or the entire tapped area may be rotted and the bast easily rubbed off. Occasionally the stripes may elongate downward and enter virgin bark. In advanced stages the latex flow is decreased.

Fruit rot and abnormal (secondary) leaf fall frequently accompany each other. Infected fruits have ashy gray, slightly wrinkled or sunken areas which frequently originate at the stem end and extend over the entire surface. The outer covering is finally involved in a soft rot. The fruits may split prematurely at the sutures or splitting may not occur at all, the diseased fruits remaining on the trees long after the normal period.

Abnormal leaf fall is distinguished from the normal leaf fall which occurs during the winter months. Soon after the new leaves appear and the rainy season begins the abnormal leaf fall of Phytophthora-infected leaves may occur. Infected leaves show dull gray spots. Petiole infection appears as a brown region about an inch in length from which a drop or two of latex may ooze. Slight leaf infection is sufficient to stimulate the development of the abscission layer and cause leaf-fall; from infected leaf stalks the fungus may grow into and kill green twigs.

For convenience the citations are given under the separate headings of the fungous species. Since the majority of writers consider *P. meadii* the cause of stripe canker, references to that disease which do not mention a causal species are placed under *P. meadii* and similar references to patch canker are placed under *P. palmivora*.

The types of infection reported are listed.

Phytophthora spp. Anstead (12) in 1924 found a species causing a die-back of young trees in India.

Weir (505) in 1929 reported a species associated with a blight or

die-back of young tissues of seedlings and buddings in Malaya and Sumatra. Murray (304) observed a similar disease in Ceylon in the same year.

P. heveae. Thompson (468) in 1929 described this species from fruit rot and black stripe in Malaya. The diseases caused by it are very similar to those caused by *P. meadii* and *P. palmivora.*

P. meadii.

Ceylon. Stripe canker. Petch (332) 1909.
Burma. Stripe canker. Dastur (122) 1916.
Federated Malay States. Stripe canker. Rutgers (386) 1913.
India. Stripe canker. Shaw (407) McRae (282) 1916.
India. Abnormal leaf fall. Butler (84) 1917.
Burma. Stripe canker, abnormal leaf fall and fruit rot. Mackenna (266) 1919.
Java. Stripe canker. van Hall (197) 1919.
India. Fruit rot and partial dying back of branches. McRae (284) 1918.
Malaya. Patch canker, secondary leaf fall and fruit rot. Sharples, Norris and others (406) 1920.
Uganda. Stripe canker. Snowden (438) 1921.
Nigeria. Stripe canker. Laycock (253) 1922.
North Borneo. Stripe canker. Bateson (40) 1923.
Belgian Congo. Stripe canker. Ringoet (378) 1923.
Brazil. Stripe canker. Weir (504) 1926.
Andaman Islands. Stripe canker. Mitra (294) 1929.

P. palmivora.

Ceylon. Patch canker. Petch (329) 1903.
Burma. Fruit rot. Dastur (122) 1903.
Ceylon. Fruit rot. Petch (329) 1905.
Trinidad. Patch canker. Rorer (380) 1911.
Kamerun. Fruit rot. Peters (342) 1912.
Java, Sumatra and Borneo. Patch canker. Rutgers (385) 1912.
Ceylon. Abnormal leaf fall. Petch (333) 1914.
Java. Stripe canker and fruit rot. Rutgers and Dammerman (389) 1914.
Uganda. Patch canker. Small (424) 1915.
India. Stripe canker, fruit rot, and leaf fall. McRae and Sundararaman (288) 1915.
Ceylon. Stripe canker. Bryce (69) 1916.
Malaya. Patch canker. Belgrave and Norris (44) 1917.
Gold Coast. Stripe canker. Bunting (75) 1918.
Brazil. Fruit rot and leaf spot. Weir (504) 1926.
Dutch East Indies. Seedling blight. Gandrup (177) 1929.

P. parasitica. Thompson (467) in 1928 reported the isolation from

patch canker in Malaya of a strain identified by Ashby (23) as probably *P. parasitica.*

JATROPHA CURCAS L. Physic Nut. Barbados Nut.

Phytophthora spp. Jensen (232) in 1911 isolated a species from seedlings in Java. Narasimhan (307) in 1930 recorded attacks on fruits in India. Attacked regions are brown at first, and later turn black. Venkata Rao (494) in 1930 reported a species in India similar to *P. arecae.*

JATROPHA GLANDULIFERA Roxbg.

Phytophthora sp. Narasimhan (306) in 1927 found a species on fruits in India.

MANIHOT GLAZIOVII Muell. Arg. Ceara Rubber Tree.

Phytophthora sp. McRae (283) in 1918 successfully inoculated this host with a species isolated from Hevea in India.

P. meadii. McRae (282) in 1916 reported infection of inoculated leaves.

MANIHOT UTILISSIMA Pohl. Yuca. Tapioca. Manioc.

P. parasitica. Matz (277) in 1919 reported this species in Puerto Rico.

RICINUS COMMUNIS L. Castor Bean. Castor Oil Plant.

P. meadii. Dastur (122) and McRae (282) in 1916 obtained infections of inoculated seedling stems and leaves.

P. nicotianae. Sidenius (413) in 1922 reported infection of young plants by this species in Sumatra. Palm and Jochems (324) in 1924 found it on seedlings in Java. Atanasoff and Kovacevski (27) reported it in Bulgaria in 1929.

P. palmivora. A subculture from F. P. Mehrlich isolated in Hawaii and labelled *P. manoana* is typical of *P. palmivora.*

P. parasitica. Dastur (121) in 1913 described the parasite from this host in India. It causes a severe seedling disease; from infected areas on the cotyledons the fungus spreads to the stems and growing points and destroys them. On older plants infection is confined to the leaves; yellowish to brown spreading spots, marked with concentric, darker brown rings, cause premature leaf fall. In 1928 Tropova (474) observed the disease in Southern Russia. Blanchard (54) in 1930 mentioned its occurrence in Argentina.

Fagaceae

CASTANEA CRENATA Sieb. and Zucc. Japanese Chestnut.

P. cinnamomi. Milburn and Gravatt[1] in 1932 reported infection of a small percentage of inoculated seedlings and larger plants.

CASTANEA DENTATA (Marsh.) Borkh. American Chestnut.

P. cinnamomi. Milburn and Gravatt[1] in 1932 isolated the species

[1]MILBURN, MARGARET and G. F. GRAVATT. 1932. Preliminary note on a Phytophthora root disease of chestnut. Phytopath. 22: 977-978.

from dying chestnuts in Georgia, South Carolina and Tennessee, affected by a disease resembling closely the European "ink disease". (See *C. sativa*). The fungus was reported as possibly *P. cambivora*. Transfers examined by the writer proved identical with *P. cinnamomi*.

CASTANEA MOLLISSIMA Blume. Chinese Chestnut.

P. cinnamomi. Milburn and Gravatt[1] in 1932 reported infection of two per cent of inoculated larger plants and none of seedlings.

CASTANEA PUMILA (L.) Mill. Chinquapin.

P. cinnamomi. Milburn and Gravatt[1] in 1932 found inoculated seedlings very susceptible.

CASTANEA SATIVA Mill. (*C. vesca* Gaertn.) Eurasian Chestnut.

P. cambivora. Delacroix (132) in 1897 recognized a connection between a fungus and the "ink disease" of European chestnuts. Petri (351) (352) (353) (354) investigated the disease and, in 1917 (355) obtained the causal fungus in culture and described it as *Blepharospora cambivora*. It attacks trees near the base of the trunk and on the larger roots; the cambium is invaded and killed. The dead cortex becomes black due to oxidation of the tannin in the cells and the growth of saprophytes (Petri) (353). Death usually results and the disease has caused extensive losses. Petri (356) believes it originated in the Azores Islands whence it has spread to Italy, Sicily, Corsica, Portugal, Spain and France.

FAGUS GRANDIFOLIA Ehrh. American Beech.

P. cactorum. This host appears in Stevenson's (453) tabulation, as attacked in Europe.

FAGUS SYLVATICA L. European Beech.

P. cactorum. Von Burgsdorf (78) in 1783 described a common seedling disease in Germany; the fungus was described by Hartig (203) in 1876 as *Peronospora Fagi*. The cotyledons and tender stems are invaded and killed, but the foliage leaves are susceptible only when very young. It has been recorded in New York by van Hook (216) in 1906 and in England by Collinge (107) in 1912; the latter used the name *P. omnivora*. Hammarlund[2] reported the species in Sweden in 1933.

P. cryptogea. Pethybridge and Lafferty (350) in 1919 reported a foot rot of inoculated seedlings.

P. syringae. Klebahn (241) in 1909 produced a disease by inoculation similar to that caused by *P. cactorum*.

QUERCUS PRINUS L. Chestnut Oak.

P. cinnamomi. Milburn and Gravatt[1] in 1932 reported infection of 2 of 81 inoculated seedlings.

QUERCUS ROBUR L. (*Q. pedunculata* Ehrh.) English Oak.

[1]See footnote on page 17.

[2]HAMMARLUND, CARL. 1933. Beiträge zur Kenntniss der Mikromycetenflora der Provinz Skane (Schonen). Ark. Bot. 25: 1-126.

P. syringae. Klebahn (241) in 1909 obtained slight infections on inoculated twigs.

Gesneriaceae

GLOXINIA SP.

Phytophthora sp. Van Poeteren (489) in 1926 reported a leaf disease in Holland. Infection appears as a dark spot on the petiole and spreads over the leaf blade.

Gramineae

AVENA SATIVA L. Oat.

Phytophthora sp. McMurphy (281) in 1916 observed a species similar to *P. colocasiae* on leaf spots and stripes in California. The infected areas are at first yellowish, then whitish and finally brown or reddish brown.

ZEA MAYS L. Corn. Maize.

Phytophthora sp. Sideris (417) in 1932 reported a species, possibly of the *P. cambivora* group, weakly parasitic to inoculated roots.

P. cactorum (?) Clinton (101) in 1919 made this identification from oospores found in rotted roots; his figures and the recent studies on root rot indicate that they may have belonged to a *Pythium sp.*

Hippocastanaceae

AESCULUS HIPPOCASTANUM L. Common Horse Chestnut. Buckeye.

P. syringae. Klebahn (241) in 1909 reported slight infections on inoculated twigs.

Iridaceae

GLADIOLUS SP. Gladiolus.

P. cryptogea. Mrs. Alcock (5) in 1929 received a report of its occurrence in England.

IRIS SP. Iris.

P. cactorum. Stevens and Plunkett (449) in 1925 reported successful inoculations with a tulip strain.

Juglandaceae

JUGLANS SP. Walnut.

P. cinnamomi. Reported from Australia by Ashby, according to a communication from R. P. White.

JUGLANS CALIFORNICA Walt. Southern Black Walnut.

P. cactorum. Barrett and Smith (36) in 1925 reported "Pythiacystis-like" fungi in connection with a crown rot in California. Barrett (34) in 1928 referred the causal agent to this species.

P. citrophthora. Smith and Barrett (427) in 1930 reported the species pathogenic.

JUGLANS HINDSII Jep. Northern Black Walnut.

P. cactorum. Smith and Smith (434) in 1925 isolated this species from crown rot in California.

P. citrophthora. Smith and Smith (434) in 1925 found this species a cause of crown rot or canker in California.

JUGLANS MAJOR Heller.

P. cactorum. Smith and Barrett (427) reported successful inoculations in 1930.

JUGLANS NIGRA L. Black Walnut.

P. cactorum. Smith and Barrett (427) reported successful inoculations in 1930.

JUGLANS PYRIFORMIS (possibly *J. intermedia* Carr. *var. pyriformis* Carr.)

P. cactorum. Smith and Barrett (427) produced infections by inoculations in 1930.

JUGLANS REGIA L. English Walnut.

P. cactorum. Barrett and Smith (37) in 1927 isolated a species from bark lesions in California; Barrett (34) identified it in 1928.

P. citrophthora. Barrett and Smith (37) in 1927 mentioned its occurrence in cankers in California.

P. parasitica. Cookson (109) in 1929 isolated the species from crown rot in Victoria, Australia, and demonstrated its pathogenicity to seedlings.

JUGLANS SIEBOLDIANA Maxim.

P. cactorum. Smith and Barrett (427) reported infections by inoculation in 1930.

Labiatae

LEUCAS LINIFOLIA (Roth.) Spreng.

P. nicotianae (?) Lodewijks (265) in 1909 reported a disease in Java with symptoms identical with those of the tobacco disease caused by this species. Jensen (232) in 1911 considered Lodewijks' conclusions doubtful or erroneous.

Lauraceae

CINNAMOMUM SP. Cinnamon.

Phytophthora sp. Ciferri (95) in 1927 found a species on dead roots of seedlings in Santo Domingo.

CINNAMOMUM BURMANNI Bl. Cinnamon.

P. cinnamomi. Rands (365) in 1922 described trunk canker, an important disease in Sumatra. Cankers appear as irregular vertical stripes of slightly sunken dead bark, one to five centimeters wide, which extend upward one to ten meters from the base. Drops of amber or wine-colored exudate appear at the rapidly advancing upper end. He isolated and described *P. cinnamomi.* The canker had been reported in 1919 by Van Hall (197).

PERSEA PERSEA (L.) Cockerell. Avocado. Alligator Pear.

P. cactorum. Barrett (33) in 1917 identified an isolation from cankered bark made by Fawcett in California in 1914.

P. cambivora. Wager[1] in 1931 isolated the species from roots of trees showing symptoms of die-back in South Africa.

P. cinnamomi. The writer (480) in 1928 described a root disease common in Puerto Rico. The small feeding roots are blackened and killed and the larger ones gradually die back. The foliage becomes pale and reduced in size; gradual defoliation is followed by the wilting of the few remaining leaves and death. Horne (221) in 1909 reported a wilting in Cuba possibly identical with the disease found in Puerto Rico.

P. citrophthora. Fawcett (161) in 1916 in California, found this species causing slightly sunken bark cankers, usually near the ground and accompanied by gum exudation. Small seedlings were also attacked. Horne (222) in 1926 obtained a firm, tough, elastic fruit rot by inoculation.

P. palmivora. Reinking (376) in 1921 noted a seedling blight in the Philippines.

Leguminosae

ARACHIS HYPOGAEA L. Peanut. Groundnut.

Phytophthora sp. Snowden (439) in 1927 reported a species associated with a root rot in Uganda.

CAJANUS CAJAN Millsp. (*C. indicus* Spreng.) Pigeon Pea.

Phytophthora sp. Sideris (417) in 1932 reported a species, possibly of the *P. cambivora* group, moderately pathogenic to inoculated roots.

CROTALARIA INCANA L.

P. meadii and *P. parasitica.* Mehrlich, in 1933, obtained infection of wounded plants (from unpublished data).

CYNOMETRA CAULIFLORA L.

P. meadii (?) Reported by Petch (338) in 1921 in Ceylon.

P. parasitica. Gadd, in a communication to the writer, considers a fungus isolated from fruits in Ceylon as *P. parasitica.* His unpublished data and drawings confirm the identification.

ERYTHRINA SP.

P. palmivora. Hartley (206) in 1924 found infections and bark cankers rare in Java.

LATHYRUS ODORATUS L. Sweet Pea.

P. cactorum (?) Clinton (101) identified oospores in the cortex of roots killed in 1907 as this species. They may have been produced by a Pythium.

LUPINUS SP. Lupine.

P. cryptogea. Brittlebank and Fish (63) in 1927 reported a stem discoloration followed by yellowing and wilting of the leaves on an ornamental lupine in Australia.

[1]WAGER, V. A. 1931. Diseases of plants in South Africa due to members of the Pythiaceae. S. Africa Dept. Agr. Sci. Bull. 105, 43 pp.

LUPINUS ALBUS L. White Lupine.

P. parasitica. Sherbakoff (410) in 1917 reported a stem rot in Florida and Peyronel (360) observed a rotting of the underground portions of young plants in Italy in 1920.

LUPINUS LUTEUS L. Yellow Lupine.

P. parasitica. A foot rot was reported in 1932 by Petri[1] in Italy.

MUCUNA GIGANTEA (Willd.) DC.

P. cinnamomi, *P. meadii* and *P. parasitica.* Mehrlich, in 1933, obtained infection of wounded seedlings (from unpublished data).

PHASEOLUS LUNATUS L. Lima Bean. Butter Bean.

P. phaseoli. Thaxter (464) in 1889 described the species from infections in Connecticut. The fungus produces white, felty patches or coverings on the pods, young inflorescences and tender tips. The pods are invaded and the young seeds are covered with hyphae. Less frequently the leaves and petioles are attacked. The disease was reported in Russia in 1897 by Speschnew (442); in Delaware in 1904 by Smith (426); in Maryland and New York in 1905 by Clinton (99); in Puerto Rico (?) in 1906 by Henricksen (211); in Virginia in 1916 by Fromme (170); in Ceylon in 1918 by Petch (335); in Minnesota in 1922 by Stakman, Leach and Seal (445); Anderson, Haskell, and others (8) in 1926 listed it in West Virginia, Ohio and California.

PHASEOLUS VULGARIS L. Garden Bean.

P. cactorum. Young (522) in 1926 reported infection of inoculated leaves.

P. citricola. Sawada (397) in 1927 reported positive inoculations of pods and seedlings.

P. palmivora. Youngberg (523) reported attacks in the Philippines in 1926.

P. parasitica. Stevenson (452) in 1917 reported in Puerto Rico a wilting and dying of the tops and a wet rot of the pods accompanied by masses of fluffy white mycelium. Reddick (369) in 1920 obtained a wet rot of pods inoculated with a tomato strain.

PISUM SATIVUM L. Garden Pea.

P. cactorum (?) Clinton (101) in 1919 observed oospores in rotted roots in Connecticut. They may have been oospores of a *Pythium sp.*

P. cambivora. Arnaudi (16) in 1928 reported results of inoculations of seedlings which he regards as evidence of the development of specific, but transitory immunization.

P. palmivora. Reinking (377) in 1923 produced a seedling blight by inoculations.

P. parasitica. Matz (277) isolated this species from pods in Puerto Rico in 1919.

[1]PETRI, L. 1932. Rassegna dei casi fitopatologici osservati nel 1931. Boll. R. Staz. Pat. Veg. n. s. 12: 1-64.

ROBINIA SP. Locust.

P. cactorum. Collinge (107) in 1912 reported a seedling disease in England.

ROBINIA PSEUDACACIA L. False Acacia. Black Locust.

P. cactorum. Stevenson (453) in 1926 included this species in his host list as attacked in Europe.

STIZOLOBIUM DEERINIANUM Bort. Velvet Bean.

P. parasitica. W. B. Tisdale, in a communication to the writer, mentioned the isolation of this species in Florida.

VIGNA SP. Cowpea.

P. parasitica. A transfer of this species isolated by Miss Schwarz in Java was received (482).

Liliaceae

ALLIUM CEPA L. Onion.

Phytophthora spp. Sideris (414) in 1929 reported successful root inoculations with five species whose specific names were not mentioned. In 1932 (417) he found a species, possibly of the *P. cambivora* group, moderately pathogenic to inoculated roots.

P. manoana. An undescribed species was reported highly pathogenic to inoculated roots by Sideris (416) in 1931. A subculture sent to the writer in 1931 by Mehrlich appears to be *P. palmivora*.

P. meadii. Reported pathogenic to inoculated roots by Sideris (416) in 1931.

P. parasitica. Reported (as *P. melongenae*) pathogenic to inoculated roots by Sideris (416) in 1931.

ALLIUM FISTULOSUM L. Welsh Onion.

P. allii. Sawada in 1915 described this species, which is probably identical with *P. parasitica*, as the cause of a leaf and flower stalk disease in Formosa. Cottony white mycelial masses appear on infected organs. (Tanaka's translation) (460).

ALLIUM PORRUM L. Leek.

P. Porri. Foister (166) in 1929 described infections by an undetermined oospore-producing species in England and Scotland. The leaf tips die back and become white; marginal infections cause a twisting of the leaves. Mature plants rot and young ones are stunted. He described the fungus as a new species in 1931 (168). Ogilvie and Mulligan (315) observed the white tip disease in the southwest of England in 1931.

LILIUM SP. Lily.

P. cactorum. Weiss and Brierley, according to Martin (272) reported a foot and stem rot in North Carolina in 1926, and Haskell and Wood (208) reported the species from Indiana and Maryland in 1930.

LILIUM CANDIDUM L. Madonna Lily.

P. cactorum. Drechsler (138) in 1925 observed a foot rot in Maryland resulting in wilting and collapse of the stems.

LILIUM DAURICUM Ker.

P. cactorum. Tasugi sent the writer a culture isolated in Japan in 1931.

LILIUM ELEGANS Thunb.

P. parasitica. Identified by the writer from an isolation by Tasugi in Japan in 1931.

LILIUM LONGIFLORUM VAR. EXIMIUM Nichols. Bermuda Easter Lily.

P. parasitica. Whetzel (511) in 1922 described a "stump rot" in Bermuda. The bulbs are attacked when, or soon after, the shoots emerge from the soil. Infection may destroy the entire stalk or only the growing tip, leaving a stump with a rosette of leaves. The disease is of economic importance. Ogilvie (313) in 1924 reported a rapid decay of the leaves, crowns and bulbs. Two isolations received by the writer are *P. parasitica* (482). Guterman (195) in 1930 reported stump rot in New York on the varieties *eximium*, *formosum* and *giganteum* growing under glass. Tasugi sent the writer an isolation made in Japan in 1932.

LILIUM PYRENAICUM Gouan. Yellow Turk's-cap Lily.

P. cactorum. Drechsler (138) in 1925 obtained this species from a rot of the basal and subterranean portions of stems occurring in Maryland.

LILIUM REGALE Wilson.

P. parasitica. The writer has examined two isolations by Drechsler. They are typically *P. parasitica* (482).

LILIUM SPECIOSUM Thunb.

P. parasitica. Guterman (195) in 1930 reported stump rot of the variety *rubrum* growing under glass in New York.

TULIPA SP. Tulip.

P. cactorum. Stevens and Plunkett (449) in 1925 recorded a shriveling and yellowish-white discoloration of flower stalks in Illinois; infected stalks collapsed and the blossoms dried up or rotted. Inoculations reproduced the disease. Schenk (399) in 1926 and Pape (325) in 1928 reported failure to obtain evidence of fungous infection in the early stages of a disease in Germany which they considered similar to the Illinois disease. Foister (167) in 1930 reported the species causing a blossom blight in England.

P. cryptogea. Mrs. Alcock (5) in 1929 reported indirect information of attacks in England. Foister (167) in 1930 stated that the roots are first attacked, the fungus advancing from them into the base of the bulb and thence into the flowering stalk. The disease is prevalent in England and Scotland.

Linaceae

LINUM USITATISSIMUM L. Flax.

P. cactorum. Stevens and Plunkett (449) in 1925 obtained a damping off of inoculated seedlings, using a tulip strain.

Loranthaceae

LORANTHUS LONGIFLORUS Desr.

Phytophthora spp. Narasimhan (307) in 1930 reported a species common in India on leaves, which become rusty brown. Venkata Rao (494) in 1930 reported a species similar to *P. arecae.*

Malvaceae

ALTHEA ROSEA Cav. Hollyhock.

P. megasperma. Drechsler (141) in 1931 described a rot of the overwintered underground portions of stems and fleshy roots resulting in collapse, wilting and death of the flowering stalks. The disease is known only from Virginia and the District of Columbia.

GOSSYPIUM BARBADENSE L. Sea Island Cotton.

P. palmivora. P. parasitica. Watts (500) in 1913 reported a boll rot in Montserrat. Attacked bolls appear water soaked and finally become blackened and shrunken and fail to open. The disease was reported from St. Vincent by Harland (201) in 1917 and from St. Kitts by Nowell (309) in 1918; from Trinidad by Ashby, (20) in 1922 and from Puerto Rico by the writer (479) in 1927. Both *P. palmivora* and *P. parasitica* can produce the disease. An isolation from St. Vincent was identified by Ashby (20) as *P. palmivora* and one from Montserrat as *P. parasitica.* Hopkins (217) identified a Trinidad isolation as *P. parasitica* and the writer's isolation in Puerto Rico was referred to the same species (482).

GOSSYPIUM HIRSUTUM L. Upland Cotton.

Phytophthora sp. Dastur (127) in 1931 observed that a species caused damping off of seedlings in India.

P. parasitica. Mitra (293) in 1929 reported infections of cotyledons, first foliar leaves and growing points resulting in death of seedlings in India.

HIBISCUS SABDARIFFA L. Roselle.

Phytophthora sp. (?) Gadd (173) in 1926 observed a damping off of seedlings and a stem disease of older plants in Ceylon. Infection occurs at the collar and progresses upward, killing the cortex. A species of Phytophthora or Pythium was isolated. McRae[1] in 1932 isolated a Phytophthora from diseased plants in India.

P. palmivora. Reinking (376) in 1921 observed a seedling blight in the Philippines.

P. parasitica. Matz (278) found this species causing a foot rot in Puerto Rico in 1920.

[1]McRAE, W. 1932. Report of the imperial mycologist. Scient. Repts. Imper. Inst. Agr. Res., Pusa, 1930-31: 73-86.

HIBISCUS SABDARIFFA L. VAR. ALTISSIMA.

Phytophthora sp. Hector (209) in 1931 described a brown discoloration and wilting in Bengal.

P. palmivora. Thompson (468) in 1929 described a disease in Malaya characterized by a dark brown band of tissue around the stem at the soil level on plants two feet or more in height. Infection may extend to the larger roots; infected areas are somewhat shrunken and may show a splitting of the epidermis and gum exudation. The disease causes a slow wilting and dying.

SIDA CORDIFOLIA L.

P. parasitica. Dastur (121) in 1913 reported attacks on the flowers in India.

Martyniaceae

MARTYNIA ANNUA L. (*M. diandra* Glox.)

P. parasitica. Dastur (123) in 1916 observed natural infections in India.

Meliaceae

SANDORICUM KOETJAPE Merr. (*S. indicum* Cav.) Santol.

P. palmivora. Reinking (377) in 1923 reported slight infections on seedlings inoculated with isolations of Philippine coconut and cacao strains.

P. parasitica. (?) Youngberg (523) in 1926 reported an unidentified species causing a seedling disease in the Philippines. Clara (98) in 1928 described a seedling blight, probably the same as referred to by Youngberg. Depressed lesions appear on the petioles, stems and cotyledons. Greenish brown, parchment-like spots develop on the leaves and the growing points are killed. The fungus was identified, almost certainly erroneously, as *P. phaseoli.* The writer, from an examination of Clara's description of it in culture, considers it very probably *P. parasitica.*

Moraceae

ARTOCARPUS INCISA L. Breadfruit.

P. palmivora. Petch (331) reported fruits attacked in Ceylon in 1907. Ciferri (96) in 1927 observed it associated with a seedling root disease in Santo Domingo.

ARTOCARPUS INTEGRIFOLIA L. Jack Fruit.

Phytophthora spp. Narasimhan (306) in 1927 reported leaf infections in India. In 1930 (307) he reported a rotting of the tender inflorescences and shedding of infected leaves. Venkata Rao (494) in 1930 reported the isolation of a species similar to *P. arecae.*

FICUS CARICA L. Fig.

Phytophthora spp. Möller (296) in 1901 reported an undetermined species in Brazil.

Venkata Rao (491) in 1916 mentioned a soft rot of fruits in India

and gave the fungus a provisional name, *P. fici*. The writer has failed to find a description.

P. hydrophila. Curzi (118) in 1927 was successful in inoculating fruits.

P. palmivora. According to Tanaka (461) *P. carica* was reported in Japan by Hara in 1909 and by Hori in 1915, and in Formosa by Sawada in 1916 on fruits. They become darker and watersoaked, followed by liquefaction. Many remain hanging and become white and longitudinally wrinkled when dry. The species has been combined with *P. palmivora* (482).

FICUS HISPIDA L. Wild Fig.

Phytophthora spp. Coleman (106) in 1920 and Narasimhan (305) in 1924 reported unidentified species in India.

FICUS RETUSA L. (*F. nitida* Thunb. and Hort.)

Phytophthora spp. Narasimhan (306) in 1927 reported an oospore-producing species on fruits in India. Venkata Rao (494) in 1930 reported a species in India similar to *P. arecae*.

Musaceae

MUSA SAPIENTUM Kuntze. Banana.

P. parasitica. Ashby (21) in 1925 isolated this species from the pseudostem of a plant attacked by *Fusarium cubense* EFS. in Trinidad. Lester-Smith (262) in 1927 referred to it as *P. parasitica*.

MUSA TEXTILIS Nee. Manila Hemp. Abaca.

P. palmivora. Hernandez (212) in 1919 found this species associated with a heart rot of pseudostems in the Philippines.

Myristicaceae

MYRISTICA FRAGRANS Houtt. Nutmeg.

P. palmivora. Zimmerman (524) in 1901 referred a species causing a die-back of seedlings in Java to *P. omnivora*. From his description it may have been *P. palmivora*. Rutgers (388) in 1917 obtained this species from a trunk canker in Java and Nowell (310) reported similar cankers in Grenada. Ciferri (95) in 1927 reported an unidentified species associated with dying seedlings in Santo Domingo.

Myrtaceae

PSIDIUM GUAJAVA L. Guava.

P. palmivora. Reinking (376) in 1921 recorded a seedling blight in the Philippines.

P. parasitica. Mitra (293) in 1929 reported a fruit rot in India. Fallen and low-hanging fruits are most frequently attacked. The surface becomes covered with mycelium and the tissues undergo a brown, soft rot.

Oleaceae

CHIONANTHUS VIRGINICA L. Old Man's Beard.

P. syringae. Klebahn (241) in 1909 successfully inoculated

wounded twigs.

FORSYTHIA VIRIDISSIMA Lindl.

P. syringae. Klebahn (241) in 1909 obtained infection of inoculated twigs.

FRAXINUS SP. Ash.

P. cactorum. Collinge (107) in 1912 reported a seedling disease in England.

JASMINUM NUDIFLORUM Lindl.

P. syringae. Klebahn (241) in 1909 successfully inoculated twigs.

LIGUSTRUM VULGARE L. Common Privet.

P. syringae. Klebahn (241) in 1909 reported successful inoculations.

SYRINGA PERSICA L. Persian Lilac.

P. syringae. Klebahn (241) in 1909 reported successful inoculations.

SYRINGA VULGARIS L. Common Lilac.

P. cactorum. Klebahn (241) in 1909 reported successful inoculations. White (513) in 1930 reported a leaf and twig blight in America caused by this species. Chester (94) in 1932 obtained two strains, one of which he described as *P. cactorum var. applanata.*

P. parasitica. Dastur (121) (123) infected leaves and small plants in 1913 and 1916 by inoculation.

P. syringae. Berkeley (49) in 1881 described the fungus in Scotland as *Ovularia syringae.* Klebahn (240) in 1905 published studies on the disease in Germany. On the leaves light brown spots appear from which the fungus grows into the stem, and in the following spring or during the winter in forcing houses, the bark on early shoots is browned and killed; flowering is greatly reduced. The disease was recorded in Holland in 1913 by Schoevers (400); in France in 1918 by Arnaud (13); in Ireland in 1925 by Pethybridge (349); in Denmark in 1925 by Gram and Rostrup (190); in Belgium in 1926 by Marchal and Verplancke (269); in northern Italy in 1927 by Peglion and Sacchetti (328); in America in 1929 by Hedges (210); and in Sweden in 1933 by Hammarlund.[1]

Onagraceae

CLARKIA ELEGANS Doug.

P. arecae. Coleman (105) in 1910 reported successful inoculations of seedlings.

P. cactorum. De Bary (131) in 1879 observed a foot and stem disease in Germany caused by this species.

P. meadii. Dastur (122) in 1916 successfully inoculated seedlings.

P. parasitica. Dastur (121) (123) in 1913 and 1916 killed seedlings by inoculations with Ricinus and Catharanthus strains.

[1]HAMMARLUND, CARL. 1933. BEITRÄGE zur Kenntniss der Mikromycetenflora der Provinz Skane (Schonen). Ark. Bot. 25: 1-126.

EPILOBIUM ROSEUM Schreb.

P. cactorum. De Bary (131) in 1881 reported infection of inoculated twigs.

GODETIA WILLDENOWIANA Spach.

P. cactorum. Meurs (290) in 1928 isolated this species from cases of foot and stem rot in Holland.

OENOTHERA SPP. Evening Primrose.

P. parasitica. Dastur (121) in 1913 infected stems and leaves by inoculation.

OENOTHERA BIENNIS L. European Evening Primrose.

P. arecae. Coleman (105) in 1910 successfully inoculated seedlings.

P. cactorum. De Bary (131) in 1881 and Klebahn (241) in 1909 infected seedlings by inoculation.

Orchidaceae

CATTLEYA SP.

P. palmivora. Schwarz (403) in 1927 reported a heart and leaf rot in Java (See *Vanda caerulea*).

DENDROBIUM CRUMENATUM Swartz.

P. palmivora. Schwarz (403) in 1927 reported positive inoculations.

DENDROBIUM MACCARTHIAE Thwaites.

P. palmivora. Petch (339) in 1921 recorded the genus on this orchid in Ceylon. Gadd (172) in 1924 identified the species as the cause of a stem infection resulting in wilting and death, also in Ceylon.

GRAMMATOPHYLLUM SPECIOSUM Blume. (*G. scriptum* Bl.)

P. parasitica. Schwarz (403) in 1927 isolated a species from a heart and leaf rot in Java and identified it, tentatively, as *P. palmivora* (*P. faberi*). A subculture in the writer's collection was identified as *P. parasitica* (482).

ONCIDIUM SP.

P. cinnamomi (?) A culture isolated in Java by Schwarz and received from Baarn shows well marked variations from *P. cinnamomi.*

PHALAENOPSIS AMABILIS Blume.

P. palmivora (?) Schwarz (403) in 1927 reported a heart and leaf rot in Java (See *Vanda caerulea*).

PHALAENOPSIS SCHILLERIANA Reichb.

P. palmivora (?) Schwarz (403) in 1927 reported a heart and leaf rot in Java (See *Vanda caerulea*).

VANDA CAERULEA Griff.

P. palmivora. Schwarz (403) in 1927 described a disease attacking various orchids in Java. Infection causes a dark discoloration at the base of young leaves. A soft rot ensues and destroys the leaf. Under

favorable conditions the fungus may invade and kill the entire stem. She identified the species as *P. palmivora* (*P. faberi*), but, following Leonian's classification, labelled it *P. omnivora*. A subculture in the writer's collection confirms her identification (482).

VANDA LIMBATA Blume.

P. palmivora. Schwarz (403) in 1927 described a disease in Java. (See *Vanda caerulea*).

VANILLA VANILLA Br. (*V. planifolia* And.) Vanilla.

Phytophthora spp. Breda de Haan (60) in 1905 found a species attacking leaves, stems and fruits in Java. Large dark spots develop on the leaves, usually near the base. Dark brown spots appear also on the stems and fruits, frequently spreading entirely over the latter. Young, tender parts are most susceptible.

Maublanc and Barat (276) in 1928 described a disease occurring in Reunion in which the fruits are invaded from the stem end and become yellow, then brown, and fall before maturity. They suggested *P. jatrophae* as the species involved, influenced apparently, by the fact that the orchid is frequently supported on *Jatropha curcas* in Reunion. Kopp (245) in 1930 reported that black lesions on stems, leaves and pods bore a fungus resembling *P. palmivora*.

Stevenson (453) in 1926 reported a serious disease caused by Phytophthora, or a closely related genus, in the Seychelles and various South Sea islands.

P. meadii. A culture isolated by Miss Schwarz in Java was received from Baarn labelled "*P. meadii*." (482).

Palmaceae

ARCHONTOPHOENIX ALEXANDRAE H. Wendl. and Drude.

P. palmivora. Reinking (377) in 1923 reported the death of wound-inoculated seedlings.

ARECA CATECHU L. Areca Palm. Betel Nut Palm.

P. arecae. Butler (82) in 1906 considered the "koleroga" disease known in India since 1870 due to a Phytophthora which invades the flowers, flowering stalks, fruits, leaf sheaths, and even the bud and growing point, the latter infections resulting in the death of the palm. Coleman (105) in 1910 published a detailed account and named the fungus *P. omnivora var. arecae*. Petch (341) in 1924 reported the fungus on fruits in Ceylon. Kuyper (248) in 1930 reported a similar disease in Sumatra.

P. palmivora (?) Gadd (174) in 1927 isolated strains which he regarded as this or a new species from diseased palms in Ceylon. He recognized the disease as very similar to or identical with that ordinarily attributed to *P. arecae*.

BORASSUS FLABELLIFER L. Palmyra Palm.

P. palmivora. Butler (82) in 1906 stated that bud rot appeared

in India in the delta of the Godavari River in 1904. The fungus penetrates the leaf sheaths and reaches the growing point, killing the palm. The earliest symptom is usually the death of the youngest leaf. Sometimes rows of brown spots across the leaves appear as evidence of infection prior to emergence, and before the fungus has reached the growing point. The disease of the Palmyra palm is similar in every respect to the bud rot of the coconut palm; Shaw and Sundararaman (408) in 1914 demonstrated their common causal agent. The Palmyra palm disease was reported from Bengal by Kar (238) in 1921.

Cocos NUCIFERA L. Coconut Palm.

Phytophthora spp. Petch (334) in 1917 isolated a species in Ceylon from nearly mature nuts showing a dark brown patch at the stem end and falling prematurely. Dark brown or black decayed areas at the bases of the lower leaf stalks causing them to collapse yielded the same fungus. Teodoro (463) in 1925 recorded a very similar disease in the Philippines.

Matz (279) in 1921 mentioned the isolation of a species from a young bud in Porto Rico.

P. arecae. McRae (285) and Sundararaman and Ramakrishnan (457) in 1924 reported attacks on immature nuts and inflorescence axes resulting in nut-fall in India. Bud rot did not appear among infected palms. Mitra (294) in 1929 observed a similar disease in the Andaman Islands.

P. palmivora. Bud rot is a widespread and very important disease. The fungus usually penetrates and kills the growing point and the earliest symptom is the death of the youngest leaf; however, as in infections of *Borassus flabellifer*, rows of spots across the leaf pinnae sometimes denote cases of incipient infection. The disease was known long before the causal organism was isolated. The malodorous, watery rot which the dead growing point rapidly undergoes led early investigators to attribute bud rot to bacteria. Butler (82) in 1906 recognized the fungous character of the infection, but erroneously identified the fungus as a *Pythium*. Mature palms are commonly attacked, but occasional seedling infections have been recorded.

The nearly universal distribution of bud rot is indicated by the following citations. Grand Cayman, Fawcett (164) in 1889; Jamaica, Fawcett (165) in 1891; Cuba, Busck (79) in 1902; Trinidad, Hart (202) in 1905; India, Butler (82) in 1906; Ceylon, Petch (330) in 1906; the Philippines, Byards (86) in 1906; Mexico, Olsson-Seffer (316) in 1912; British Guiana, Bancroft (31) in 1915; British East Africa, Dowson (137) in 1915; South Africa, Evans (154) in 1915; Fiji, Knowles (244) in 1916; Nigeria, Johnson (233) in 1919; St. Lucia, Watts (501) in 1921; Malaya, Sharples and Lambourne (405), who did not consider the Malayan disease of Phytophthora origin, in 1922; Santo Domingo, Faris (155) in 1923; New Guinea, Bryce (71) in 1924; Puerto Rico, the writer (477) in 1925;

the Seychelles Islands, Dupont (144) in 1926; Guam, Vanderberg (485) in 1926.

Petch (336) in 1920 considered a species found in connection with nut-fall in Ceylon as possibly identical with *P. palmivora*.

P. parasitica. Ashby (18) in 1920 isolated this species from a rot near the bases of leaf stalks in Jamaica. A culture isolated from bud rot by Reinking in the Philippines sent to the writer by Hartley was referred to *P. parasitica* (482).

Cocos plumosa Hook.

P. palmivora. Burger (77) in 1924 reported a bud rot in Florida with symptoms like those of coconut and Palmyra palm infections.

Dypsis madagascariensis Nichols.

P. palmivora. Reinking (377) in 1923 reported bud rot of wound-inoculated seedlings.

Elaeis guineensis L. Oil Palm.

Phytophthora sp. Reported on over-ripe fruits in the Belgian Congo in 1929 by Staner (446).

Howea Belmoreana Becc. (*Kentia Belmoreana* F. Muell.)

P. palmivora. Labrousse (250) in 1931 isolated the species from palms attacked by bud rot in a glasshouse in southern France.

Livistona rotundifolia Mart.

P. palmivora. Reinking (377) in 1923 successfully inoculated wounded seedlings.

Nonmanbya merrillie (?)

P. palmivora. Reinking (377) in 1923 reported the species susceptible to wound-inoculation.

Phoenix dactylifera L. Date Palm.

P. palmivora. Reinking (377) in 1923 obtained medium to severe infections of wound-inoculated seedlings.

Pinanga insignis (?)

P. palmivora. Reinking (377) in 1923 killed seedlings by wound-inoculation.

Ptychosperma macarturi H. Wendl.

P. palmivora. Reinking (377) in 1923 reported medium to severe infection of wounded seedlings.

Rhopalostylis Baueri H. Wendl. and Drude.

P. palmivora. Labrousse (250) in 1931 isolated the species from palms attacked by bud rot in a glasshouse in southern France.

Sabal causiarum (Cook) Becc. Puerto Rican Hat Palm.

P. palmivora. The writer (478) in 1927 described a bud rot in Puerto Rico very similar to that of coconut palms.

Washingtonia Sonorae Wats.

Phytophthora sp. (?) Montemartini (298) in 1928 recorded a case of bud rot in Rome which resembled coconut bud rot. The causal

organism was not determined.

Papaveraceae

ESCHSCHOLTZIA CALIFORNICA Cham. California Poppy.

P. cactorum. Meurs (290) in 1928 reported a foot and stem rot in Holland.

PAPAVER NUDICAULE L. Iceland Poppy.

Phytophthora sp. Brittlebank (61) in 1919 reported browning and decay at the bases of the leaves and on the flower stalks in Australia. Plants are attacked at any stage of growth and the disease is destructive.

P. cryptogea. Brittlebank and Fish (63) in 1927 described a discoloration at the base of the stem and a yellowing of the leaves among plants about two inches in height in Australia. Infected plants die before flowering.

Papayaceae

CARICA PAPAYA L. Tropical Papaw. Papaya.

P. palmivora. Reinking (372) in 1918 observed a soft rot of fruits in the Philippines. Hartley (206) in 1924 found natural infections rare in Java. Gadd (172) in 1924 reported a canker at the base of stems in Ceylon. Campbell (87) in 1925 found an unidentified species associated with a fruit rot and dying of plants in Fiji. Ciferri (95) in 1927 reported a species associated with rotting of young plants in Santo Domingo.

Pedaliaceae

SESAMUM ORIENTALE L. (*S. indicum* L.) Sesame.

Phytophthora sp. Ciferri (97) in 1930 reported a destructive foot rot in Santo Domingo and attributed it to an unidentified species.

P. parasitica. Dastur (121) in 1913 noted a disease of seedlings in India; the leaves become blackened and curled.

Pinaceae

P. cactorum. (?) Jorstad (236) in 1925 reported *P. omnivora* as a cause of damping off in coniferous nurseries in Norway; Sibilia (412) reported the same species in Germany causing damping off in 1928.

ABIES SP. Fir.

P. cactorum. Hartig (204) in 1882 recorded the species on seedlings in Germany.

LARIX SP. Larch.

P. cactorum. Hartig (204) in 1882 reported attacks on seedlings in Germany and Hiley (213) in 1919 reported *P. omnivora* in England. Van Poeteren (490) in 1930 reported the latter in infected roots of seedlings in Holland.

PICEA SP. Spruce.

P. cactorum. Van Hook (216) in 1906 reported a serious attack on nursery seedlings in New York; Collinge (107) in 1912 reported it on seedlings in England.

PICEA ENGELMANNI Engelm.

P. citrophthora. Rathbun-Gravatt (368) in 1931 observed that the fungus invades the seeds before emergence of the radicles.

PICEA EXCELSA Link. (*Abies excelsa* Lam. et DC.)

P. cactorum. Voglino (497) in 1916 reported a seedling disease in Italy.

PINUS SP. Pine.

P. cactorum. Hartig (204) in 1882 mentioned attacks on seedlings in Germany.

PINUS BANKSIANA Lamb. Gray Pine. Northern Scrub Pine.

P. citrophthora. Rathbun-Gravatt (368) in 1931 observed that the species invades the seeds before the emergence of the radicles.

P. pini. Hartley (205) in 1921 and Rathbun-Gravatt (367) in 1925 found an isolation, later described by Leonian (259) as *P. pini*, capable of causing damping off.

PINUS MONTANA Mill. Swiss Mountain Pine.

P. cactorum. Stevenson (453) in 1926 included this among the European hosts.

PINUS PONDEROSA Doug. Yellow Pine. Bull Pine.

P. pini. Hartley (205) in 1921 produced damping off by inoculation.

PINUS RESINOSA Ait. Red Pine. Norway Pine.

Phytophthora sp. Rathbun-Gravatt (366) in 1923 infected seedlings with an unidentified species.

P. cactorum. Rathbun-Gravatt (367) in 1925 produced damping off by inoculation. A beech strain proved more virulent than one from a host not mentioned.

P. citrophthora. Rathbun-Gravatt (367) in 1925 obtained 100% damping off of inoculated seedlings. She reported in 1931 (368) that the fungus invaded the seeds before the emergence of the radicles.

P. pini. Rathbun-Gravatt (367) in 1923 reported damping off of inoculated seedlings.

PINUS SYLVESTRIS L. Scotch Pine.

P. cactorum. Collinge (107) in 1912 reported a seedling disease in England; Dimitroff (133) in 1926 recorded attacks by *P. omnivora* on seedling roots and needles in Bulgaria, and Hammarlund[1] in 1933 reported the fungus in seed-beds in Sweden.

Piperaceae

PIPER BETLE L. Betel. Pan.

Phytophthora spp. Dastur (124) (125) in 1925 and 1926 reported serious damage in India by a species which attacks the stems near the

[1]HAMMARLUND, CARL. 1933. BEITRÄGE ZUR KENNTNISS DER MIKROMYCETENFLORA DER PROVINZ SKANE (SCHONEN). Ark. Bot. 25: 1-126.

soil level and extends downward. Wilting and death of the vines follow. Similar diseases were observed in Malaya by Thompson (466) in 1926 and in Ceylon by Small (425) in 1928.

P. colocasiae. Ashby (23) in 1928 identified an isolation by Thompson in Malaya as this species. Thompson (467) in 1928 reported that the fungus produced oospores in culture at Kew, but not in Malaya.

P. parasitica. Dastur (126) in 1927 reproduced the disease with an isolation from India similar to *P. parasitica.* McRae[1] in 1932 identified isolations from Madras and Bengal as this species.

PIPER NIGRUM L. Pepper.

Phytophthora sp. Venkata Rao (493) in 1929 reported a wilt disease in Mysore.

Platanaceae

PLATANUS OCCIDENTALIS L. Sycamore.

P. cactorum. Collinge (107) in 1912 reported a seedling disease in England.

Polemoniaceae

GILIA SPP.

P. meadii. Dastur (122) in 1916 successfully inoculated seedlings.

GILIA CAPITATA Doug.

P. cactorum. De Bary (131) in 1879 observed stem infections in Germany.

GILIA TRICOLOR Benth. (*G. nivalis* Hort.)

P. colocasiae. Butler and Kulkarni (85) in 1913 obtained infection of cotyledons and hypocotyls followed by death in 60 to 70% of unwounded inoculated seedlings.

P. cryptogea. Pethybridge and Lafferty (350) in 1919 reported a foot rot of inoculated seedlings.

P. parasitica. Dastur (121) (123) in 1913 and 1916 successfully inoculated seedlings with two strains.

Polygonaceae

FAGOPYRUM ESCULENTUM Moench. Buckwheat.

P. parasitica. Dastur (121) in 1913 killed seedlings by inoculation.

FAGOPYRUM MARGINATUM (*F. esculentum* Moench) (?)

P. cactorum. De Bary (131) in 1879 observed a foot and stem disease in Germany.

FAGOPYRUM TATARICUM Gaertn. India Wheat. Duck Wheat.

P. cactorum. De Bary (131) in 1879 observed foot and stem infections in Germany.

[1]MCRAE, W. 1932. Report of the imperial mycologist. Scient. Repts. Imper. Inst. Agr. Res., Pusa, 1930-31: 78-86.

RHEUM RHAPONTICUM L. Rhubarb. Pie Plant.

Phytophthora sp. Barrett (35) in 1927 reported a species on infected petioles, crowns and roots in California.

P. cactorum. Beach (41) in 1921 recorded a crown rot in Pennsylvania and published a full description in 1922 (42). It appears as a wilting of the leaves caused by the invasion and destruction of tissues of the primary roots, crowns and bases of the petioles. Young buds are attacked and blackened while yet in the crown or when just above the soil; only in very wet weather does infection extend far above the soil. The disease may be produced by either *P. cactorum* or *P. parasitica* and isolation of the organism is advisable to distinguish them. A culture of *P. cactorum* isolated by I. T. Scott in Missouri was examined and the identification verified.

P. parasitica. Beach (42) in 1922 reported an unidentified species causing a disease in Illinois very similar to that described above caused by *P. cactorum.* No culture has been available but the description of the fungus in culture leaves no doubt that it is *P. parasitica.*

Godfrey (188) in 1923 described a disease in the District of Columbia, Maryland, Virginia, and Pennsylvania caused by a species which he described as *P. parasitica var. rhei.* The symptoms are very like those produced by *P. cactorum.* The variety should be abandoned as the fungus falls well within the limits now ascribed to *P. parasitica* (482). Doidge (135) in 1924 observed the disease in South Africa and attributed it to this species. Hopkins (218) in 1931 reported the species in Southern Rhodesia and the writer isolated it from specimens of foot rot in Missouri in 1932.

Ranunculaceae

NIGELLA DAMASCENA L. Love-in-a-Mist.

Phytophthora sp. An unidentified species causing rot of roots and stems was isolated by the writer in Missouri in 1932.

PAEONIA ALBIFLORA Pallas. Peony.

P. cactorum. Attacks on buds, leaves, stems and occasionally, on crowns, result in a dark brown or black rot which may be soft and wet or somewhat leathery, depending upon environmental factors subsequent to infection. The disease was reported from Pennsylvania by Thurston and Orton (469) in 1921; Kansas, by White, according to Martin (270) in 1922; Connecticut, by Clinton, according to Martin (271) in 1923; Indiana, by Gardner (180) in 1925; and Japan by Tasugi and Kumazawa[1] in 1932. Cooper and Porter (110) in 1928 described the fungus as *P. paoniae* n. sp. A culture in the writer's collection agreed so closely with *P. cactorum* in morphological and cultural characters that its separation was not considered advisable (482).

[1]TASUGI, HEIZI and MATASAKE KUMAZAWA. 1932. Phytophthora blight of peony. Jour. Imper. Agr. Exp. Sta. (Tokyo) 2:75-96. (English Summary).

PAEONIA SUFFRUTICOSA Andr. (*P. Moutan* Sims). Tree Peony.

P. cactorum. Tasugi and Kumazawa[1] in 1932 reported the host susceptible to inoculation.

THALICTRUM POLYGAMUM Muhl. Tall Meadow Rue.

P. thalictri. Clinton (100) reported this species in Connecticut in 1908.

THALICTRUM PURPURASCENS L. Meadow Rue.

P. thalictri. Wilson (517) in 1907 described the species from material collected by Davis in Wisconsin. It causes dark brown to almost black, suborbicular or irregular areas on the leaves.

Rosaceae

CRATAEGUS OXYACANTHA L. Hawthorn. May.

P. syringae. Klebahn (241) in 1909 reported successful twig inoculations.

CYDONIA OBLONGA Mill. (*C. vulgaris* Pers.) Quince.

P. citricola. Sawada (397) reported successful inoculations of seedlings.

P. hydrophila. Curzi (118) in 1927 obtained infections of inoculated fruits.

ERIOBOTRYA JAPONICA Lindl. Loquat.

P. cactorum. Isolated in Japan in 1932 and sent to the writer by Tasugi.

P. parasitica. Dufrenoy (143) in 1927 isolated a strain from trunk lesions in Corsica, and named it P. *omnivora parasitica forma eriobotryae.* The writer suggested discarding the unwieldy name for *P. parasitica* (482).

FRAGARIA CHILOENSIS VAR. ANANASSA (Duch.) Hort. Strawberry.

P. cactorum. Osterwalder (320) in 1912 reported an infection of fruits in Switzerland by *P. omnivora*; Rose (381) in 1924 found the disease destructive in Arkansas, Tennessee and Missouri. "Leather rot" attacks fruits in all growth stages; the tissues become tough and leathery, discolored internally and externally, and usually markedly bitter in taste. The vascular tissues are more conspicuously browned than the fleshy tissue. Attacks on very young fruits may result in browning of the receptacle, stamens, calyx and peduncle. Anderson, Haskell and others (8) in 1926 recorded the disease in the additional states of Kentucky, Mississippi, and Louisiana. Arnaud (14) in 1928 observed a disease, probably identical with leather rot, in France. Beaumont and Hodson (43) in 1930 isolated the species from rotting fruits in England.

P. cryptogea (?) Mrs. Alcock (5) in 1929 described a root disease in Scotland. Roots become grayish brown and die back from the tips, resulting in a marked sparsity of fibrous and lateral roots. The fungus ex-

[1]See footnote on opposite page.

tends most rapidly in the central cylinder causing a reddish discoloration which suggests the term "red core root." Infected plants are stunted and gradually die. The fungus was not isolated. Alcock, Howells and Foister (6) in 1930 reported that the fungus resembles *P. cinnamomi*. They failed to obtain growth on media.

PRUNUS SPP.

Phytophthora spp. Smith and Smith (434) in 1925 isolated a group of strains or species from trunk cankers on various hosts. They considered the isolations as forming a closely connecting series between *P. cactorum* and *P. citrophthora*. Examination of their descriptions indicates that the isolations are definitely one or the other species and that they do not exhibit intermediate characters. The fact that they showed little or no selectivity as to hosts and could not be distinguished by the character of infection produced does not preclude the presence of two distinct species among the strains.

P. cactorum. Unamuno (484) in 1911 reported this species in Spain.

PRUNUS ARMENIACA L. Apricot.

P. cactorum. Barrett (33) considered an isolation from a bark canker in 1916 in California very similar to this species.

P. citrophthora. Smith and Hunt (429) in 1922 described cankers which girdled young trees just above the bud in California. Attacks on older trees are less severe.

PRUNUS AVIUM L. Sweet Cherry.

P. cactorum. *P. citrophthora*. Smith and Smith (434) in 1925 reported both species causing a crown or trunk canker in California.

PRUNUS CERASUS L. Sour Cherry. Morello Cherry.

P. syringae. Klebahn (241) in 1909 killed twigs by inoculation.

PRUNUS COMMUNIS Fritsch. Almond.

P. cactorum. Smith (428) in 1914 isolated an oospore-producing species from bark cankers in California. Smith and Barrett (427) in 1930 reported successful inoculations.

P. citrophthora. Smith (428) in 1914 obtained this species from bark cankers on nursery stock in California.

PRUNUS DAVIDIANA Franch. Wild Peach.

P. citrophthora. Smith (428) in 1914 produced bark cankers by inoculation.

PRUNUS DOMESTICA L. Plum.

Phytophthora sp. (?) Smith and Smith (434) in 1925 isolated a Phytophthora or Pythium from bark cankers in California.

P. cactorum. Smith and Barrett (427) in 1930 reported successful bark inoculations.

P. syringae. Klebahn (241) in 1909 reported slight infections on

inoculated twigs.

PRUNUS PERSICA (L.) Stokes. Peach.

P. cactorum. Smith and Smith (434) in 1925 isolated the species from cankers common on bearing trees in California.

P. citrophthora. Smith (428) in 1914 described cankers on nursery stock in California. The trunks are girdled above the bud and gumming frequently accompanies infection. Root stocks are rarely invaded by the downward growth of the fungus.

PYRUS COMMUNIS L. Pear.

P. cactorum. A rot of fallen fruits originating from contact with the soil and of fruits on lower branches is not uncommon. The invaded region becomes light brown and spongy or soft with a deeper browning of the vascular tissues. Externally the rotted region becomes dark brown to black. The disease was reported in Switzerland by Osterwalder (317) in 1905; in Belgium by Marchal (268) in 1908; in Bohemia by Bubak (72) in 1910; in Spain by Unamuno (484) in 1911; in Holland by Schoevers (401) in 1915; in Austria in 1916 (9); in Nova Scotia by Gussow (194) in 1919; in Connecticut by Clinton (101) in 1919; in England by Wormald (520) in 1919; in Michigan by Rose and Lindegren (382) in 1925; in Indiana by Gardner (181) in 1927; in France by Arnaud and Barthelet (15) in 1929; and in Washington in 1931 by Heald and others.[1] Smith and Barrett (427) in 1930 reported successful inoculations of bark.

P. citrophthora. Smith (428) in 1915 reported bark cankers on nursery stock in California. They originate at the bud union and extend about a foot up the trunk. Hunt (228) in 1921 found twig and branch infections resulting in killed areas of bark 6 to 12 inches long in northern California.

P. syringae. Klebahn (241) in 1909 killed twigs by inoculation; Lafferty and Pethybridge (251) in 1922 produced a fruit rot identical with *P. cactorum* rot. Ogilvie (314) in 1931 reported natural fruit infection in the southwest of England.

PYRUS MALUS L. Apple.

Phytophthora sp. Petri[2] in 1931 observed mycelium of an unidentified species in necrotic tissue of trees affected by a collar rot in Italy.

P. cactorum. Fruit infections usually originate from contact with the earth, either on fallen fruits or on those on low-hanging branches. A slight browning, externally and internally, and a marked browning of the vascular tissues, results from invasion. The tissues become mealy

[1]HEALD, F. D., L. K. JONES, and G. A. NEWTON. 1931. Plant pathology. Wash. Agr. Exp. Sta. Bull. 260: 13, 14, 47-50, 62, 63.

[2]PETRI, L. 1932. Rassegna dei casi fitopatologici osservati nel 1931. Boll. R. Staz. Pat. Veg. n. s. 12: 1-64.

or granular due to the dissolution of the middle lamellae; a spongy rot rather than a soft, mushy one is characteristic. Fruit infection was reported in Switzerland by Osterwalder (317) in 1905; in Illinois by Barrett (33) from study of a culture isolated in 1908; in England by Wormald (520) in 1915; in New York by Whetzel and Rosenbaum (512) in 1916; in Connecticut by Clinton (101) in 1918; in Indiana by Jackson (230) in 1922; in Pennsylvania by Thurston, according to Adams (3) in 1922; in Holland by Van Poeteren (487) in 1923; in Michigan, Washington and Idaho by Rose and Lindegren (382) in 1925; in Virginia by Anderson, Haskell and others (8) in 1926.

Osterwalder (319) in 1912 observed dying of young grafts in Switzerland, caused by the growth of hyphae between the epidermis and bast and in the cambium. In 1929 (321) he reported the overwintering of the fungus in dead twigs and infection of fruits three to four weeks old.

P. syringae. Lafferty and Pethybridge (251) in 1922 found this species causing fruit rot identical with the *P. cactorum* rot, in Ireland. Ogilvie (314) in 1931 reported a fruit rot in the southwest of England caused by a strain differing from the one reported in Ireland.

Rubiaceae

CINCHONA LEDGERIANA Moens.

P. palmivora (?) McRae (286) in 1928 reported a blight of young Cinchona seedlings in India. He did not identify the fungus, but his description indicates its probable position. In 1930 (287) he reported the host as *C. Ledgeriana.*

RICHARDSONIA SCABRA St. Hil.

P. meadii and *P. parasitica.* Mehrlich, in 1933, obtained infections of unwounded seedlings (from unpublished data).

Rutaceae

CITRUS SPP.

Phytophthora spp. The disease or diseases of various Citrus species known as foot rot, collar canker, sore shin, gum disease, mal di gomma, gummosis, etc., are usually caused by one of two or three species. Infection commonly occurs near the base of the trunk and extends upward and downward; patches of bark on the trunk and larger roots are killed, often accompanied by a more or less copious exudation of gum. The bark, including the cambium, is killed to the wood; girdling and the death of the tree are often the final stage. The disease is widely distributed and early reports indicate its long-standing economic importance. According to Curtiss (117) it was present in the Azores in 1832, in Portugal in 1845 and in Sicily in 1863. Fawcett (162) found evidence of its occurrence in the United States in 1865, in Australia in 1867, in Spain in 1871 and in California in 1875. Cruz (116) reported foot rot in the Philippines in 1909.

Fawcett (159) in 1915 attempted to distinguish between the diseases caused by *P. citrophthora* and *P. parasitica*. The former was stated to cause bark cankers which extend farther above the base of the trunk and are accompanied by larger amounts of exuded gum than cankers caused by *P. parasitica*. However, lesions produced by parallel inoculations were difficult to distinguish.

Writers have frequently referred to Citrus as a genus rather than to individual species when reporting diseases. Such references are here reported under the heading "*Citrus spp.*" and reports of the infection of particular species will be cited in appropriate places.

Marked specific variations in susceptibility to foot rot or gummosis have long been known. According to Fawcett (162) the lemon is most susceptible, followed in order of susceptibility by the sweet orange, grapefruit, rough lemon, trifoliate orange and sour orange. In 1896 Swingle and Webber (459) recommended the use of the sour orange and grapefruit as budding stock.

In addition to root and trunk diseases various species attack fruits, leaves and twigs. These infections will be described in connection with their specific hosts.

The following records of the occurrence of identified species on the genus in general are included to make the citations as complete as possible.

P. citrophthora. Averna-Sacca (28) recorded the species in Brazil in 1912; Petri (357) in 1924 reported this or an allied species as the cause of a root rot in Sardinia; it was stated by Dufrenoy (142) in 1925 to cause a foot rot in Corsica, and in Sicily in 1928 by Petri (359).

Fawcett (163) in 1930 reported the species as the cause of brown rot of fruits and gummosis in Spain, Sicily and Egypt, and of gummosis in Palestine.

P. hibernalis. Bensaude (47) in 1929 considered the fruit rot described in Portugal by Moniz da Maia (297) caused by this species, and reported its occurrence on leaves as well as fruits.

P. hydrophila. Curzi (118) in 1927 obtained positive results in inoculations of the fruits of several species.

P. palmivora. Reinking (376) in 1921 reported attacks on seedlings in the Philippines. The tender tips of seedlings and young shoots are blackened and killed. The identification was confirmed in 1927 by Ocfemia and Roldan (312).

P. parasitica. This species was recorded on various unnamed species in Florida by Sherbakoff (410) in 1917; in Puerto Rico by Matz (277) in 1919; in the Philippines by Lee (256) in 1921; in Argentina by G. L. Fawcett (157) in 1922; in Cuba by Bruner (68) in 1923; and in

Sicily by Petri (359) in 1928. Weindling[1] isolated it from damped-off seedlings in California in 1932.

CITRUS AURANTIFOLIA Swing. Lime.

P. citrophthora. Fawcett (162) in 1923 reported the lime very susceptible to gummosis, and Staner (447) in 1929 reported the disease in the Belgian Congo.

Pope (361) in 1923 observed a fruit rot in Hawaii.

P. palmivora. Ocfemia and Roldan (312) in 1927 observed a very slight seedling blight in the Philippines.

CITRUS AURANTIUM L. Sour Orange.

Phytophthora sp. (?) Kamat (237) in 1927 reported a Phycomycete in cases of gummosis in India.

P. palmivora. Ocfemia and Roldan (312) in 1927 reported a slight infection by seedling blight in the Philippines and a slow bark rot on stems one to three centimeters in diameter, inoculated below the surface of the soil.

CITRUS LIMONIA Osbeck. Lemon.

Phytophthora sp. Narasimhan (306) in 1927 observed an undetermined species on fruits in India.

P. cactorum. Smith and Barrett (427) in 1930 reported successful bark inoculations.

P. citrophthora. Smith and Smith (433) in 1906 investigated brown rot, an important fruit disease in California. On the trees a brownish area soon involves the entire fruit, which falls to the ground. Infected fruits retain their original size and shape and remain solid and firm in texture. The rot may develop and spread in packed fruit. A rancid odor is evolved.

Fawcett (158) in 1913 found this species causing a gummosis and foot rot of trees in California.

Records of its occurrence on lemons are: New Zealand by Cockayne and Cunningham (103) in 1907 as the cause of a fruit rot and the death of the small lateral and larger branches; in Argentina by G. L. Fawcett (156) in 1916; in New South Wales by Darnell-Smith (119) in 1918; in Italy by Traverso (473) in 1921; in a greenhouse in New Jersey by Anderson, Haskell and others (8) in 1926.

P. hibernalis. Carne (88) in 1925 described a leaf blight and fruit rot in Australia. The leaf blight phase is conspicuous. In the same year Moniz da Maia (297) described a species on fruits in Portugal which Carne (88) and Bensaude (47) regarded as identical with *P. hibernalis.*

P. palmivora. Ocfemia and Roldan (312) in 1927 recorded a medium severe seedling blight in the Philippines.

[1]WEINDLING, R. 1932. *Trichoderma lignorum* as a parasite of other soil fungi. Phytopath. 22: 837-845.

CITRUS MAXIMA Merrill. Shaddock. Pummelo.

P. palmivora. Ocfemia and Roldan (312) in 1927 observed a medium severe seedling blight in the Philippines.

P. parasitica. Lee (257) in 1925 reported slight susceptibility to foot rot in the Philippines.

CITRUS MEDICA L. Citron.

P. citri. Venkata Rao (491) in 1916 found an oospore-producing species on fruits in India and proposed the name *P. citri.* No description has been seen. Narasimhan (306) in 1927 reported an oospore-producing species, also on fruits in India.

P. citrophthora. Fawcett (162) in 1923 reported marked susceptibility to gummosis, and Staner (447) in 1929 observed the disease in the Belgian Congo. Sirag el Din (423) in 1931 reported serious gummosis in trees on *C. medica* stocks in Egypt.

P. palmivora. Ocfemia and Roldan (312) in 1927 observed a slight seedling blight in the Philippines.

CITRUS NOBILIS Lour. King Orange.

P. palmivora. Ocfemia and Roldan (312) in 1927 reported a severe seedling blight in the Philippines.

CITRUS NOBILIS VAR. DELICIOSA Swingle. Mandarin. Tangerine.

P. citrophthora. Staner (447) in 1929 reported the species causing gummosis in the Belgian Congo. Klotz and Fawcett (242) in 1930 found inoculated trees moderately resistant.

P. hibernalis. Cole (104) in 1921 described a disease in Victoria (Australia) which Carne (88) considered caused by this species. Carne also attributed a fruit rot described by Moniz da Maia (297) in Portugal in 1925 to *P. hibernalis.*

CITRUS PARADISI Macf. Grapefruit. Pomelo.

Phytophthora spp. Two isolations from rotting fruits imported from Puerto Rico were made by H. R. Fulton. Subcultures were obtained from Drechsler by the writer (482).

P. citrophthora. Fawcett (159) in 1915 isolated the species from foot rot in Florida and Cuba. George, according to Adams (3) in 1922 reported attacks on stems in Arizona. Staner (447) reported gummosis in 1929 in the Belgian Congo; Guiscafre (193) recorded the species in Puerto Rico and Sharangapani (404) in Bengal in 1930. Wager[1] identified it as the cause of gummosis and collar rot in South Africa in 1931; Fawcett[2] isolated the species from fruits in Florida in 1932.

P. hibernalis. Cole (104) in 1921 reported a disease in Australia which Carne (88) attributed to this species.

[1]WAGER, V. A. 1931. Diseases of plants in South Africa due to members of the Pythiaceae. S. Africa Dept. Agr. Sci. Bull. 105, 43 pp.

[2]FAWCETT, H. S. 1932. Two Phytophthoras of Citrus found in new localities. U. S. Dept. Agr. Plant Dis. Reporter 16: 130.

P. palmivora. The writer (481) in 1928 found fallen fruits in Puerto Rico invaded on the side in contact with the soil, by a fairly firm, brown rot. Invaded peel becomes tough and somewhat leathery. No infection of fruits on the tree was observed. A blight of seedlings invaded the young tender tips and leaves. Brownish green blotches appeared on the latter and defoliation resulted, leaving dead, blackened, shrunken stems.

P. parasitica. Fawcett (159) in 1915 observed marked susceptibility to foot rot among some strains of *C. paradisi*; Stevens (451) in 1918 found the fungus prevalent in Florida; Matz (278) in 1920 reported foot rot in Puerto Rico.

CITRUS SINENSIS Osbeck. Sweet Orange.

P. citricola. Sawada (397) in 1927 described this species from a fruit rot in Formosa.

P. citrophthora. Fawcett (160) in 1915 isolated this species from foot rot in California; George, in 1922, according to Adams (3), reported stem infections in Arizona. Doidge (136) in 1925 observed a fruit rot, leaf fall and twig blight in South Africa. Staner (447) in 1929 reported the species as the cause of gummosis at lower altitudes in the Belgian Congo. Fawcett[1] in 1932 isolated it from fruits in Florida and Louisiana.

P. hibernalis. Carne (88) considers fruit rots described by Tryon (476) in 1920 in Queensland, Cole (104) in 1921 in Victoria, and Samuel (393) in South Australia and attributed to *P. citrophthora*, and a disease described in Portugal by Moniz da Maia (297), all probably caused by *P. hibernalis.* Infection causes defoliation, twig blight and fruit decay. The low-hanging fruits are the first to become infected and the ensuing decay is identical with rots produced by *P. citrophthora* and *P. parasitica.* No foot rot or gummosis occurs. Fawcett[2] in 1932 isolated the species from fruits in California.

P. palmivora. Park[2] observed a dying back of young shoots in wet weather in Ceylon in 1931.

P. parasitica. Fawcett (159) in 1915 observed a foot rot in Florida differing from typical *P. citrophthora* infections; Stevens (450) in 1917 isolated a species which differed in growth characters from *P. citrophthora*, and in 1918 (451) identified it as *P. parasitica* (*P. terrestris*). This species was recorded in the Philippines by Lee (256) in 1922; in California in 1912 by Fawcett (162); in Java in 1930 by Toxopeus (472); in Argentina in 1930 by Blanchard (54); and in Uruguay in 1931 by Acosta (2).

Dufrenoy (142) regarded the species isolated in Portugal by Moniz da Maia (297) as similar to Leonian's *P. omnivora parasitica* (*P. parasitica*).

[1]See footnote on page 43.

[2]PARK, M. 1932. Report on the work of the mycological division. Ceylon Admin Repts. Rept. of Dir. Agr. 1931: D103-D111.

CITRUS TANKA Hay.

P. citricola. Sawada (397) in 1927 reported a fruit rot in Formosa.

FORTUNELLA SP. Kumquat.

P. hibernalis. A disease reported by Cole (104) in Victoria in 1921 was attributed to this species by Carne (88).

LIMONIA POGGEI VAR. LATIALATA. (?)

P. citrophthora. Staner (447) in 1929 reported very rare attacks in the Belgian Congo.

Santalaceae

SANTALUM ALBUM L. Sandal.

Phytophthora spp. Venkata Rao (492) in 1925 and Narasimhan (306) in 1927 reported unidentified species on the leaves in India. In 1930 (307) the latter reported that the fungus attacks tender shoots, flowers and leaves. Brown patches appear on the leaves and abscission occurs. In the same year Venkata Rao (493) reported his isolation as similar to *P. arecae.*

Sapotaceae

MIMUSOPS ELENGI L.

P. palmivora. Bunting (76) in 1925 reported a very severe fruit rot in the Gold Coast; Ashby (24) in 1929 identified the species.

Saxifragaceae

RIBES SPP.

P. cactorum. Van Poeteren (489) in 1926 described infections near the soil level which cause dead areas on the stems of various varieties in Holland. It was considered probably identical with a disease reported from Switzerland. (See *R. Grossularia*).

RIBES GROSSULARIA L. European Gooseberry.

P. cactorum. Müller-Thurgau, Osterwalder and Jegen (302) in 1922 reported *P. omnivora* (*P. cactorum*) in Switzerland; Van Poeteren (486) in the same year described a browning and dying of twigs in Holland.

Scrophulariaceae

ALONSOA CAULIALATA Ruiz. and Pav.

P. cactorum. De Bary (131) in 1879 observed a foot and stem disease in Germany.

ANTIRRHINUM MAJUS L. Snapdragon.

P. cryptogea. Brittlebank and Fish (63) in 1927 described infections causing discoloration at the bases of stems, followed by a yellowing of the foliage.

P. palmivora. The writer in 1929 isolated this species from plants in Puerto Rico. At about flowering time the stem bases become darkened and the roots decay, much as in the infection described by Sundararaman and Ramakrishnan (458) in India.

P. parasitica. Hopkins (218) in 1930 isolated the species in Southern Rhodesia and reported its identity in 1931 (219). A culture isolated in Hawaii, labelled *P. melongenae*, was received from F. P. Mehrlich in 1932.

P. pini var. antirrhini. Sundararaman and Ramakrishnan (458) in 1928 in India, described this new variety, which causes a collar rot which may extend to the roots. The woody tissue becomes water soaked and brown or black in color. Unfortunately no culture of the organism has been available. The temperature relations of *P. pini* (482) indicate that the occurrence of the species in the tropics is unusual.

CALCEOLARIA INTEGRIFOLIA Murr. (*C. rugosa* Ruiz. and Pav.)

P. cactorum. Osterwalder (318) in 1909 reported invasion near the soil surface and extension upward and downward in the stems in Switzerland. Wilting and death result.

Solanaceae

ANTHOCERCIS VISCOSA R.

P. infestans. Kühn (246) in 1859 reported leaf infections in Germany.

ATROPA BELLADONNA L. Belladonna.

Phytophthora sp. Barker (32) in 1917 reported a root disease in England.

P. erythroseptica. Westerdijk and van Luijk (508) in 1920 considered it the cause of a root rot in Holland. Mrs. Alcock (4) in 1926 suggested the provisional name, *P. erythroseptica var. atropae* for a fungus which attacks this host in Scotland. A wilt follows infection of the stem near the soil level; small seedlings are damped-off.

CAPSICUM ANNUUM L. Pepper.

Phytophthora sp. Trotter (475) in 1924 reported a seedling disease in Italy. Stems are browned and constricted, especially near the collar.

P. cactorum (?) Voglino (496) in 1913 described a foot rot, wilting and death in Italy. Green, nearly mature fruits are invaded and rotted. His description of the fungus indicates that the identification as *P. cactorum* was possibly erroneous.

P. capsici. Leonian (258) in 1922 described this species from a disease occurring in New Mexico. Fruit attacks cause dry, bleached to dull straw-colored lesions which become sunken and parchment-like, and involve a quarter or more of the fruit. The seeds are brown and shriveled. Young, tender branches are frequently invaded, and girdling and killing of larger ones may occur. Infections at the bases of stems or branches cause wilting or death of the parts above the infected area.

The writer (481) in 1928 observed blackening and collapsing of tender tips and brownish green blotching of the leaves of young plants in Puerto Rico. Infected parts become mealy in appearance due to profuse

production of sporangia. The writer has seen a culture isolated in Florida by G. F. Weber which appears to be this species. Weber[1] reported the disease in 1932.

P. hydrophila. Curzi (118) in 1927 described this species from infections in Italy. Invasion of the collar causes a ring of dead tissue which may spread upward to the branches or downward to the roots. Fruit infections are usually confined to those in contact with the soil.

P. parasitica. Kendrick (239) in 1923 in Indiana reported attacks on green fruits with the appearance of small, green, water soaked spots which spread to involve most of the surface and cause premature dropping. From the fruit the fungus grows into the pedicel, but does not extend into the stem.

DATURA STRAMONIUM L. Jimson Weed. Stramonium.

P. hydrophila. Curzi (118) in 1927 reported virulent infections of young tender inoculated plants, but none on older ones.

HYOSCYAMUS NIGER L. Black Henbane.

P. infestans. Smith (436) in 1884 reported natural infection in England. Garbowski (178) in 1913 infected inoculated detached leaves but failed to infect attached ones. Vowinckel (498) in 1926 secured infection by leaf inoculation.

LYCIUM HALIMIFOLIUM Mill. Common Matrimony Vine.

P. infestans. Vowinckel (498) in 1926 reported natural infections in Germany.

LYCIUM OBOVATUM Ruiz and Pav.

P. hydrophila. Curzi (118) in 1927 infected fruits by inoculation.

LYCIUM TURCOMANIKUM Turcz.

P. infestans. Vowinckel (498) in 1926 found this host quite susceptible to leaf inoculations.

LYCOPERSICON LYCOPERSICON (L.) Karst. (*L. esculentum* L.) Tomato.

Phytophthora spp. Undetermined species were reported by Bancroft (30) in 1910 as *P. omnivora* from a brown rot of fruits in England; by Barker (32) in 1917 from collar rot in England; by Petch (335) in 1918 from a leaf, fruit and stem disease in Ceylon; by Spinks (443) in 1918 from collar rot and damping off in England; by Darnell-Smith (120) in 1921 from a seedling disease in Australia.

P. arecae. Coleman (105) in 1920 secured infections on very small inoculated seedlings. Larger ones were not attacked.

P. cryptogea. Pethybridge and Lafferty (350) in 1919 described infections in Ireland. The fungus usually invades the roots and grows into the base of the stem where it causes a brown or black discoloration.

[1]WEBER, G. F. 1932. Blight of peppers in Florida caused by *Phytophthora capsici.* Phytopath. 22: 775-780.

The soft, parenchymatous tissue is destroyed and the stem collapses. The leaves may remain turgid for a short time after the plant has fallen over. Plants about six inches tall are frequently killed. The collar rots described by Barker (32) and Spinks (443) in England could have been caused by *P. cryptogea*. Bewley (50) in 1920 reported it as causing damping off in England, and Cotton (113) considered it generally distributed in the south of England. The species was recorded in Denmark in 1922 by Weber (502) and in Australia by Brittlebank and Fish (63) in 1927.

P. hydrophila. Curzi (118) in 1927 reported virulent infection of inoculated fruits and very young seedlings. Older plants were resistant.

P. infestans. The important disease known as late blight is characterized by the appearance of a whitish gray, downy fungus growth on leaves and stems. It may be very inconspicuous or dense enough to cause an easily visible whitish "bloom." Attacked parts quickly become brown and watersoaked and defoliation and wilting of the stems follow. Fruits may become infected at any stage of growth with the development of brownish-green, hard, leathery, somewhat sunken areas, usually originating at the stem end from peduncle and sepal infections. Seed bed infection may cause a condition similar to damping off. (Milbrath) (292).

The species was recorded on the tomato in France in 1854 by Tulasne (483); in Germany in 1859 by Kühn (246); in England in 1881 by Smith (435); in the United States (Connecticut) in 1889 by Thaxter (465); in Italy in 1896 by Solla (440); in India in 1900 by Butler (81); in Russia in 1897 by Speschnew (442); in Belgium in 1901 by Marchal (267); in Puerto Rico in 1906 by Henricksen (211); in Mexico in 1908 by Gándara (175); in Australia in 1910 by Johnston (234); in Ecuador in 1911 by Cordero (112); in Mauritius in 1915 by Stockdale (454); in Hawaii in 1917 by Carpenter (89); in Uruguay in 1917 by Girardi (184); in Canada (Ontario) in 1917 by Howitt (225); in Jamaica in 1918 by Ashby (17); in Algeria in 1921 by Steeg (448); in South Africa in 1922 by Doidge (134); in the Philippines in 1922 by Welles (507); in Poland in 1925 by Siemaszko (421); in Argentina in 1925 by Girola and Araujo (186); in Spain in 1926 (10); in Santo Domingo in 1927 by Ciferri (95); in Denmark in 1928 by Gram and others (189); in 1931 in Texas by Taubenhaus and Ezekiel (462) and in Esthonia by Lepik (261).

Reddick (370) in 1928 reported *P. infestans* common on the tomato in California and in the Piedmont section of the Alleghanies.

P. mexicana. This species was isolated from fruits imported from Mexico in 1917 and described by Hotson and Hartge (223) in 1923. Inoculations caused a black wilt and damping off of young plants. Fruits shriveled and decayed without the appearance of zonate markings.

P. nicotianae. Reported in Bulgaria in 1929 by Atanasoff and Kovacevski (27).

P. palmivora. Coleman (105) in 1910 successfully inoculated seedlings.

P. parasitica. A rot of fruits near or in contact with the soil is the most common type of infection. Dark green water-soaked areas appear, becoming, later, grayish to dark greenish brown, concolorous or marked by more or less distinct zonation. The entire fruit becomes soft, wet and dripping. Reddick (369) in 1920 described a disease in greenhouses in New York, in which the fungus may cause damping off of seedlings; a girdling of stems of any age at any point and the death of the parts above the girdle; a rapid rot of fruits and a root infection resulting in death. Natural fruit or leaf infections were not observed. Examination of Reddick's isolation permitted its classification as *P. parasitica* (482).

In France in 1847 Payen (326) (327) observed a fruit rot and production of sporangia. Inoculations of potato tubers with infected tomato tissues produced infection very readily, and a reddish coloration developed in the tuber tissue. Payen supposed he was working with *P. infestans*, but his results suggest that he was using a fruit infected by *P. parasitica.*

The species was reported, frequently as *P. terrestris*, as occurring in Florida probably as early as 1911 by Sherbakoff (411); in Puerto Rico in 1916 by Stevenson (452); in Cuba in 1918 by Bruner (66); in Arkansas (1917), Texas and Louisiana (1918) and Virginia in 1919 by Weimer (503); in Ceylon in 1920 by Petch (337); in England in 1920 by Bewley (50) as a cause of damping off; in North Carolina in 1921 by Wolf (519); in a greenhouse in British Columbia in 1922 by Eastham (147); in Indiana in 1923 by Kendrick (239); in Holland in 1925 by Van Poeteren (488); in Ireland in 1925 by Pethybridge (349) as the cause of a greenhouse leaf and fruit disease; in Argentina in 1930 by Blanchard (54); and in Maryland in 1932 by Hunter[1].

Distribution is probably general in the Gulf and South Atlantic states.

NICOTIANA TABACUM L. Tobacco.

P. nicotianae. The disease appears both in seed beds and in fields. Typical symptoms of black shank develop after transplanting; dry, black, rotted areas appear on the stems near the surface of the soil and advance downward and upward, sometimes half way up the stem. The pith in infected regions becomes dry and brown and split into disc-like plates. Brown streaks of infected cortical tissue may extend upward nearly to the bud. The roots may be invaded and destroyed before infection becomes visible above the ground. On the leaves, principally the lower ones, large brown blotches one to three inches in diameter may appear. Petioles may be infected with the formation of lesions. Plants

[1]HUNTER, H. A. 1932. Notes on some of the important diseases of canning crops in Maryland. U. S. Dept. Agr. Plant Dis. Reporter 16:175.

may be attacked at any age. Even on harvested leaves blotches may develop from the continued growth of the fungus. Seed bed infection causes a wet rot or damping off. (Tisdale) (470).

This or a very similar disease was reported in Sumatra and Java by Breda de Haan (58) (59) in 1893 and 1896; in Cuba in 1909 by Horne (221); in the United States in Georgia in 1915 by Tisdale (470); in Florida it appeared between 1915 and 1920, according to Tisdale (470); in the Philippines in 1918 by Reinking (372); in Ceylon in 1922 by Petch (340); in Puerto Rico in 1924 by Cook (108); in Virginia in 1924 by Wingard and Godkin (518); in Germany in 1924 by Hoffman (215); in Jamaica in 1926 by Hansford (199); in Nyasaland in 1928 by Gibson (183) who considered a Pythium the causal agent; in Uganda in 1928 by Hansford (200); in Bulgaria in 1929 by Atanasoff and Kovaceski (27); in Roumania in 1930 by Savulescu (394); and in Mauritius in 1931 by Shepherd (409). Kuyper (247) in 1928 reported an epidemic on flooded lands in Java in which leaves suffered while stems were scarcely attacked.

P. parasitica. Ashby (18) in 1920 reported this species on stems in Jamaica; stem infections were also noted in Puerto Rico in 1920 by Matz (278) and in Trinidad in 1928 by Ashby (23). Blanchard (54) reported the species in Argentina in 1930.

P. tabaci. Sawada (397) in 1927 published a Japanese description of this species which infects stems in Formosa.

PETUNIA SP. Petunia.

P. cryptogea. Pethybridge and Lafferty (350) in 1919 reported a foot rot of seedlings in Ireland. The disease is very similar to that produced by this species in tomato plants.

P. infestans. Smith (436) in 1884 included this genus in a host list. Samuel[1], in 1931, observed seedling infection in South Australia.

P. parasitica. Dastur (123) in 1916 recorded its occurrence on seedlings in India.

PETUNIA HYBRIDA Hort. Petunia.

P. infestans. Lagerheim (252) in 1891 reported infections in Sweden.

PHYSALIS ALKEKENGI L. Winter Cherry.

P. infestans. Vowinckel (498) in 1926 secured slight infection of inoculated leaves.

PHYSALIS COZTOMATL (*P. ixocarpa* Brot.) (?).

P. infestans. Gándara (175) in 1908 reported infection of *P. coztomatl* (tomate). *P. coztomatl* may be a synonym of *P. ixocarpa* Brot. which, according to Bailey (29) is known as "tomate."

SALPIGLOSSIS SPP.

P. meadii. Dastur (122) in 1916 successfully inoculated seedlings.

[1]SAMUEL, G. 1932. Summary of plant disease records in South Australia for the two years ending June 30th, 1932. Jour. Dept. Agr. S. Australia 36:300-301.

SALPIGLOSSIS SINUATA Ruiz. and Pav. (*S. variabilis* Hort.)

P. arecae. Coleman (105) in 1910 infected seedlings by inoculation.

P. cactorum. De Bary (131) in 1881 and Klebahn (241) in 1909 successfully inoculated seedlings.

P. parasitica. Dastur (121) (123) in 1913 and 1916 killed seedlings by inoculation with two strains.

SCHIZANTHUS GRAHAMII Gill.

P. infestans. De Bary (130) in 1876 reported a blight-like disease attacking stems, leaves and buds in Germany.

SCHIZANTHUS PINNATUS Ruiz. and Pav.

P. cactorum. De Bary (131) in 1879 observed a foot and stem disease in Germany.

SCHIZANTHUS RETUSUS Hook.

P. parasitica. Dastur (121) (123) in 1913 and 1916 killed seedlings by inoculations with two strains.

SCHIZANTHUS WISETONENSIS Hort.

P. arecae. Coleman (105) in 1910 successfully inoculated seedlings.

SOLANUM ATROPURPUREUM Schrank.

P. infestans. Hammarlund[2], in 1933, recorded leaf, stem and fruit infections in Sweden.

SOLANUM AVICULARE Forst. (*S. laciniatum* Ait.)

P. infestans. Kühn (246) in 1859 recorded leaf and fruit infections in Germany. Brittlebank (62) in 1920 reported natural infections in Australia. Marchal and Foex[1] reported severe attacks in France in 1931; and Hammarlund[2] in 1933 recorded leaf, stem, and fruit infections in Sweden.

SOLANUM CALDASII Humb. and Bonpl.

P. infestans. Recorded in France in 1931 by Marchal and Foex.[1]

SOLANUM CARDIOPHYLLUM Lindl.

P. infestans. Smith (436) in 1884 included this species in a host list.

SOLANUM CARIPENSE Kunth.

P. infestans. Lagerheim (252) in 1891 reported infections in Ecuador.

SOLANUM COMMERSONII Dun.

P. infestans. Labergerie (249) in 1904 reported slight leaf infection in France; infections were reported as abundant in England in

[1]MARCHAL, P. and E. FOEX. 1932. Rapport phytopathologique pour l'année 1931. Ann. des Epiphyties 18: 1-53.

[2]HAMMARLUND, CARL. 1933. Beiträge zur Kenntniss der Mikromycetenflora der Provinz Skane (Schonen). Ark. Bot. 25. 1-126.

1905 by Jones (235). In the United States (Vermont) Stuart (455) (456) recorded infections in 1905 and 1906.

SOLANUM DEMISSUM Lindl.

P. infestans. Lindley (264) in 1848 reported this host very susceptible in England.

SOLANUM DULCAMARA L. Bittersweet.

P. infestans. Natural infections were recorded in Germany in 1847 by Corda (111); in Mexico in 1908 by Gándara (175); in England in 1913 by Smith (430); and in Russia in 1926 by Bondartzeva-Monteverde (55).

SOLANUM EDINENSE Berthault.

P. infestans. Susceptibility was observed in England in 1910 and 1912 by Salaman, according to Pethybridge (348); and in Germany by Broili (65) in 1921 and Müller (300) in 1928.

SOLANUM ETUBEROSUM Lindl.

P. infestans. Infections were reported in Holland in 1845 by Bergsma (48); in France in 1854 by Tulasne (483); in the United States (Vermont) in 1906 by Stuart (456); and in England in 1910 by Salaman (390).

SOLANUM FENDLERI Gray.

P. infestans. Reddick (370) in 1928 reported successful inoculations.

SOLANUM JAMESII Torrey.

P. infestans. Reddick (370) in 1928 reported infection by inoculation.

SOLANUM MAGLIA Molin. Darwin Potato.

P. infestans. Natural infections were recorded in Germany in 1861 by De Bary (128); in the United States (Vermont) in 1906 by Stuart (456). Jones (235) in 1905 observed infection in England of a *S. Maglia—S. tuberosum* hybrid.

SOLANUM MARGINATUM L.

P. infestans. Hammarlund[1] in 1933 reported leaf, stem, and fruit infections in Sweden.

SOLANUM MELONGENA L. Eggplant.

Phytophthora spp. Undetermined species were reported by Reinking (377) causing a fruit rot and seedling blight in the Philippines in 1923. Trotter (475) in 1924 reported *P. omnivora* responsible for a stem infection of seedlings in Italy; Proshkina-Kobezakaya (363) in 1928 reported Phytophthora infection in Ukrainia.

P. arecae. Coleman (105) in 1910 found very small seedlings susceptible to inoculation, but larger ones were resistant.

P. hydrophila. Curzi (118) in 1927 reported positive inoculations on fruits.

[1]See footnote on page 51.

P. infestans. Occasional infections of this host have been reported as causing a fruit rot and lesions on the pedicels and calyces. Leaf infection is rare. This species was recorded in Germany in 1847 by Corda (111); in the United States (New York) in 1921 by Haskell (207); in France in 1925 by Simonet (422); in Russia in 1926 by Bondartzeva-Monteverde (55); in Santo Domingo in 1927 by Ciferri (95); and in Poland in 1928 (?) by Garbowski (179).

P. nicotianae. Reported in Bulgaria in 1929 by Atanasoff and Kovacevski (27).

P. parasitica. A fruit rot characterized by dark colored, circular or irregular watersoaked lesions is produced by infection at any stage of growth. Infected fruits are shed early. The disease was observed in Formosa in 1914 by Sawada, who described the fungus as *P. melongenae*, according to Tanaka's (460) translation; in the Philippines in 1918 by Ocfemia (311); in the United States (Indiana) in 1923 by Kendrick (239); and in Jamaica in 1925 by Ashby (22). Nolla, in 1928, sent the writer a culture isolated from a rotting fruit in Puerto Rico.

SOLANUM MURICATUM Ait. Melon Pear. Melon Shrub.

P. infestans. Lagerheim (252) in 1891 and Cordero (112) in 1911 reported fruits very susceptible in Ecuador. Pachano (322) in 1920 described the symptoms as dark spots with lighter concentric rings; the spots increase in size and finally cover the surface and a wet rot destroys the fruit. His drawings of sporangia and sporangiophores suggest *P. parasitica* rather than *P. infestans*, but he did not culture or describe the fungus. There is hardly sufficient evidence to doubt the determination, but a further study of the parasite seems to be warranted.

SOLANUM NIGRUM L. Common Nightshade.

P. infestans. Corda (111) in 1847 reported infection in Germany. De Bary (129) in 1863, and Vowinckel (498) in 1926, successfully inoculated leaves.

SOLANUM POLYADENIUM (?)

P. infestans. Stuart (455) in 1905 observed slight infections in Vermont.

SOLANUM PYRACANTHUM Jacq.

P. infestans. Hammarlund[1] in 1933 reported leaf, stem, and fruit infections in Sweden.

SOLANUM STOLONIFERUM Schl.

P. infestans. Infections were reported in France in 1854 by Tulasne (483) and in the United States (Vermont) in 1905 by Stuart (455).

SOLANUM TUBEROSUM L. Potato. Irish Potato.

Phytophthora spp. Pethybridge (347) in 1918 reported a foot rot in Ireland caused by an undetermined species.

[1]See footnote on page 51.

Drechsler (140) in 1923 isolated a species from tubers from Oklahoma and Kentucky which causes a pink rot; the fungus exhibited diplanetism, the primary zoospores delivering the protoplast through an evacuation tube to form secondary zoospores.

P. Drechsleri. Described in 1931 by the writer (482) from an isolation by Drechsler from a rotted tuber from Idaho.

P. erythroseptica. Pethybridge (343) in 1912 described a tuber rot occurring in Ireland. Infection originates in the field at the stem end and causes a firm, somewhat elastic rot; on exposure to the air invaded tissue turns pink and finally dark brown or nearly black. In 1914 (345) infection of underground parts of the stem caused a wilt, and root invasion resulted in yellowing, rolling and drying of the foliage. This species was reported in England in 1922 by Cotton (115); in Holland in 1915 by Pethybridge (346) and in 1923 by Van Poeteren (487); and in Bulgaria by Atanasoff and Kovacevski (27) in 1929.

P. hydrophila. Curzi (118) in 1927 successfully inoculated tubers.

P. infestans. The potato late blight or top rot is one of the most important of the Phytophthora diseases. During summers of favorable meteorological conditions the potato crops in the northeastern United States and in Europe are greatly reduced. The disease probably appeared in both regions between 1830 and 1845, but escaped serious attention until the cool, wet summer of 1845 when the crop was nearly destroyed.

The disease has been under investigation since 1845 and a large number of articles have appeared, especially on control measures. Controversies have arisen as to whether the disease was introduced from South America, the natural habitat of the potato, into North America and Europe or was already present, in Europe, on other hosts. Another controversial point has been the ability of the fungus to hibernate in the tubers and infect young shoots the following spring. The question of oospore formation was long and bitterly argued.

Epidemics usually appear at about flowering time. On the leaves irregular, dark brown to black blotches appear and spread rapidly. Stems show elongated brown lesions. In wet weather a wet, ill-smelling rot destroys the foliage and diseased fields resemble frosted ones. The tubers are invaded while yet in the ground by a brown, firm rot marked externally by somewhat discolored, slightly sunken areas. Slightly infected tubers are frequently overlooked and decay in storage.

Eriksson (149) (150) investigated the early appearances of the disease in Europe and recorded the following dates and distribution: Germany (1830), England (1835), Bavaria (1840), Norway (1841), Sweden and Denmark (1842). Other records of its appearance are as follows: in Belgium in 1842 by Morren (299); in the Bogotá plateau

of northern South America in 1845 and earlier, according to Acosta's description of a disease in a communication to Boussingault (57); in Holland, France, Russia, the Isle of Wight, Ireland and Canada in 1845 by Morren (299); in Hungary in 1846 by Moesz (295); in Australia in 1846 by McAlpine (280); in Finland in 1847 by Grotenfelt (192); in India in 1875 or earlier by Butler (81); in New Zealand about 1892 by Cockayne (102); in Natal in 1902 by Fuller (171); in South Africa in 1903 by Nobbs (308); in Mexico in 1907 by Escobar (151); in Ecuador in 1911 by Cordero (112); in Tasmania in 1911 by Lea (254); in Java in 1914 by Rutgers (387); in Mauritius in 1915 by Stockdale (454); in Cuba in 1915 by Jehle (231); in Hawaii in 1917 by Carpenter (89); in the Philippines in 1918 by Reinking (372); in Japan in 1918 by Ito (229); in Bermuda in 1919 by Wortley (521); in Jamaica in 1920 by Ashby (19); in Argentina in 1921 by Girola (185); in Morocco in 1921 by Miége (291); in Malta in 1923 by Borg (56); in Greece in 1925 by Cavados (91); in the Azores in 1926 by Bensaude (46); in Spain in 1926 (10); in Peru in 1927 by Abbot (1); in Tunis in 1927 by Chabrolin (92); in Puerto Rico in 1929 by Barrus (38); in Guatemala in 1932 by Palm[1].

In the United States the disease was epidemic in 1842 in the northeastern states, according to Smith (431); the northeastern and north central states suffer severely in years favorable to blight development. Other sections where the disease is common are Florida, where it was reported in 1903 by Hume (227), and California, where Smith (432) recorded its occurrence in 1904. The less humid regions are usually free from blight, although Bisby and Conners (52) reported it in Manitoba in 1928, and Taubenhaus and Ezekiel (462) reported a severe outbreak in Texas in 1931.

P. parasitica. Identified in 1931 by the writer (482) from isolations by Drechsler from rotted tubers from Kentucky and Oklahoma. Most strains cause a rapid rot of inoculated tubers and Dastur (121), in 1913 produced a blackening and shriveling of leaves and a wilting of young stems, by inoculations.

SOLANUM UTILE Klotzsch.

P. infestans. Münter (303) in 1849 reported infections in Germany. Kühn (246) in 1859 observed leaf infection on a hybrid of *S. utile—S. tuberosum* parentage.

SOLANUM VERRUCOSUM Schl.

P. infestans. Infection was observed in France in 1854 by Tulasne (483); Reddick (371) in 1932 reported the species on wild plants in Mexico.

[1]PALM, B. 1932. PFLANZENKRANKHEITEN aus Guatemala. Zeitschr. Pflanzenkrankh. u. Pflanzenschutz 42:11-17.

Sterculiaceae

COLA VERA K. Schum.

Phytophthora sp. Ciferri (95) in 1927 reported a species associated with a root disease of seedlings in Santo Domingo.

THEOBROMA CACAO L. Cocoa. Cacao.

P. palmivora. The diseases caused by this species, pod rot, trunk and branch canker, and wilt of young seedlings or shoots are important in most countries where the host is cultivated on a commercial scale. The pods are usually invaded at the stem end and turn brown; they remain firm and finally dry up and remain attached. From infected fruits the fungus may grow through the pedicel into the fruiting cushion and produce a canker which results in a suppression of flowering and, occasionally, the death of branches or the entire tree.

The causal organism was identified in 1899 by Massee (275) as *P. omnivora.* The disease was reported in Trinidad in 1727, according to a record obtained by Gadd (172); in Ceylon in 1899 by Massee (275); in Grenada and Dominica in 1901 by Howard (224); in Jamaica in 1903 by Earle (146); in Kamerun in 1903 by Preuss (362); in Victoria (West Africa) in 1905 by Busse (80); in St. Lucia and British Guiana in 1905 by Lewton-Brain (263); in Santo Domingo in 1910 by Barthe (39); in St. Vincent and St. Kitts in 1911 by South (441); in Surinam in 1912 by Essed (152); in Mexico in 1912 by Martinez (274); in Java in 1912 by Rutgers (384); in Nigeria in 1913 by Evans (153); in Samoa in 1913 by Friederichs (169); in San Thomé and Principe in 1914 by Almeida (7); in the Philippines in 1915 by Ghofulpo (182); in Uganda in 1915 by Small (424); in the Gold Coast in 1916 by Bunting (74); in Fiji in 1916 by Knowles (243); in Ecuador in 1916 by Martinez (273), who identified the fungus, certainly erroneously, as *P. cactorum*; in Brazil in 1917 by d'Utra (145); in Cuba in 1918 by Bruner (67); in Siam in 1921 by Reinking (375); in New Guinea in 1924 by Bryce (70); in the Belgian Congo in 1928 by Bellefroid (45); and in Guatemala in 1932 by Palm[1].

THEOBROMA PENTAGONA Bern. Alligator Cacao.

P. palmivora. Rutgers (388) in 1912 isolated this species from a fruit attacked by brown rot in Java.

Tiliaceae

TILIA PLATYPHYLLOS Scop. Large-leaved Lime.

P. syringae. Klebahn (241) in 1909 reported slight infections of inoculated twigs.

Ulmaceae

TREMA AMBOINENSIS Blume.

P. nicotianae. Palm (323) in 1923 obtained slight infection by inoculation.

[1]See footnote on page 55.

Umbelliferae

APIUM GRAVEOLENS L. Celery.

P. cryptogea. Cotton (114) in 1922 isolated this species from damping off seedlings in England.

DAUCUS CAROTA L. Carrot.

P. nicotianae. Tisdale and Kelley (471) in 1926 reported a soft, watery rot of wound-inoculated roots.

P. parasitica. Godfrey (188) in 1923 obtained a dark, clear, watery decay of inoculated roots.

PASTINACA SATIVA L. Parsnip.

P. parasitica. Godfrey (188) in 1923 produced a soft wet rot and a pinkish or light purplish surface discoloration of inoculated roots.

Urticaceae

BOEHMERIA NIVEA Gaud. Ramie.

Phytophthora sp. Butler (83) in 1912 observed infections in India.

P. boehmeriae. Sawada (397) in 1927 described this species which attacks leaves in Formosa.

CELTIS OCCIDENTALIS L. Hackberry. Sugarberry.

Phytophthora sp. Sheldon, according to Martin (270), in 1922 reported abundant witches' brooms caused by an unidentified species in West Virginia. Leonian, in a letter to the writer, expressed the opinion that the record was erroneous, as no evidence had been observed of any connection between the disease and a Phytophthora.

MORUS SP. Mulberry.

Phytophthora sp. (?). Petri (358) in 1928 ascribed a root disease in Italy to a fungus, probably a Phytophthora. Analogies were noted between this disease and Phytophthora attacks on chestnuts and Citrus.

Violaceae

VIOLA SP. Violet. Pansy.

Phytophthora sp. Salmon and Ware (392) in 1930 reported that pansies in England withered and died following infection of roots and stem bases by an unidentified species.

REMARKS

Natural infections have been recorded on 216 host species, representing 149 genera and 67 families. Inoculations have proven the susceptibility of 82 additional species representing 45 additional genera and 6 families. The number of hosts susceptible to inoculation is of little significance. It has been noted that certain species show little selectivity of hosts wound-inoculated under favorable conditions.

The geographical distribution of the species of Phytophthora is determined by moisture and temperature conditions. All species are

favored by high humidity and their occurrence in semi-arid regions where certain other fungi, e. g. Uredinales and Ustilaginales, thrive, is uncommon. In tropical and subtropical regions *P. palmivora*, *P. parasitica*, *P. nicotianae*, *P. colocasiae*, *P. citrophthora*, *P. arecae* and *P. meadii* are frequently reported. Species encountered in the temperate regions are *P. infestans*, *P. phaseoli*, *P. thalictri*, *P. cactorum*, *P. syringae*, *P. erythroseptica*, and *P. cryptogea*. Other species are so rarely recorded that a statement regarding their distribution is not justified. Among such species are *P. mexicana*, *P. Boehmeriae* and *P. megasperma*, the last reported only from the vicinity of Washington, D. C.

These general statements regarding distribution are subject to numerous exceptions. *P. infestans* has often appeared in the tropics, especially at cool altitudes. *P. parasitica* is frequently found in temperate regions, particularly where summer temperatures are high.

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